BRUNSON MODEL 270BN

OPERATION INSTRUCTION
AND
MAINTENANCE MANUAL

FOR

BRUNSON MODEL 270BN

UNIVERSAL SHORT RANGE CALIBRATOR

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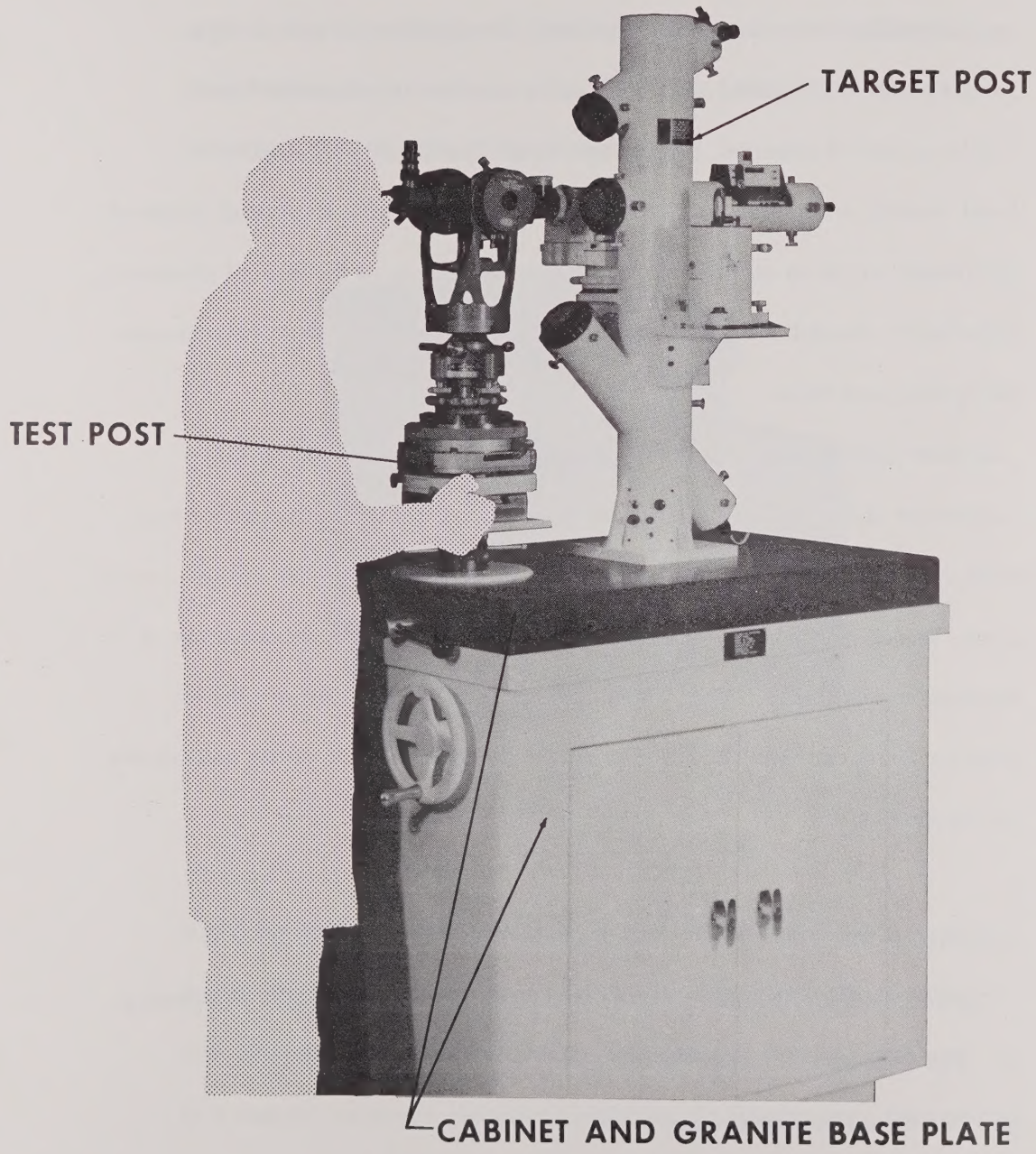
I. INTRODUCTION

The Brunson Universal Short Range Calibrator (USRC) is the result of a concentrated effort to produce a calibrator for surveying and optical tooling instrumentation. The project was started to achieve two major goals:

1. Design and build a calibrator to occupy the smallest possible floor space without sacrificing the accuracy of larger calibrators.
2. Provide for horizontal circle calibration of transits, levels and theodolites, and also provide for checking straightness of the line of sight or short focus collimation.

This calibrator's 2-1/2 x 3-1/2 x 6 ft. size fulfills the first design goal. As a consequence of the calibrator's small size the additional advantage of convenience is also realized. A single operator can check the geometry of the calibrator and its components without the need for an assistant. Although the calibrator is not "portable" in the usual sense of the term, its compactness and combination of features make it especially adaptable to trailer mounting to perform field calibration and/or adjustment without the necessity for removing the instruments from the general area in which they are needed. (ie. periodic calibration of sight levels, transits, and theodolites at a remote construction site or calibration and adjustment of optical tooling instrumentation in field use.)

UNIVERSAL SHORT RANGE CALIBRATOR



II. GENERAL DESCRIPTION

Although small in size, the Universal Short Range Calibrator provides a full range of test functions such as checking of: surveying instruments and optical tooling instruments for geometry, straightness of line of sight (short focus collimation), action of compensators in automatic levels, circle errors of transits, levels, and theodolites, and coordination of level vials to an optical axis. Calibrators equipped with an optical plummet collimator are also capable of checking the accuracy of the optical plummets installed in theodolites as well as optical plummet instruments manufactured by Kern and Wild.

Another convenience provided by the Brunson Universal Short Range Calibrator is the ability to check the accuracy of transit collimation using only one collimator. This is accomplished by the use of a 360 station, seven inch, Model A Ultradex indexing table, the only major component not of Brunson manufacture. The guaranteed accuracy of this unit of plus or minus one quarter arc second also makes possible the theodolite and transit circle checks.

III. DETAILED DESCRIPTION

The complete Calibrator (see fig. 1) consists of three major sub groups:

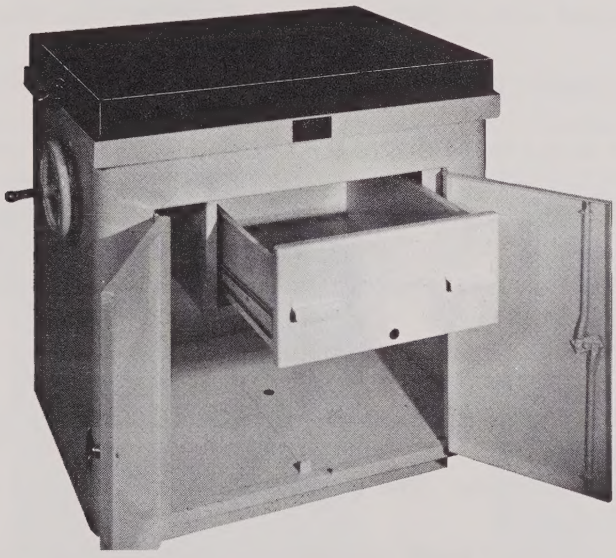
A. The Cabinet and Granite Base Plate.

B. The Test Post (upper and lower).

C. The Target Post.

A. Cabinet Description

The reinforced steel Cabinet supports the Base Plate and houses the lower portion of the Test Post. It also provides storage space for accessories, carrying cases, tools, etc., which need to be kept close at hand, (see fig. 2). Five 110 volt outlets are located on the left side of the cabinet.



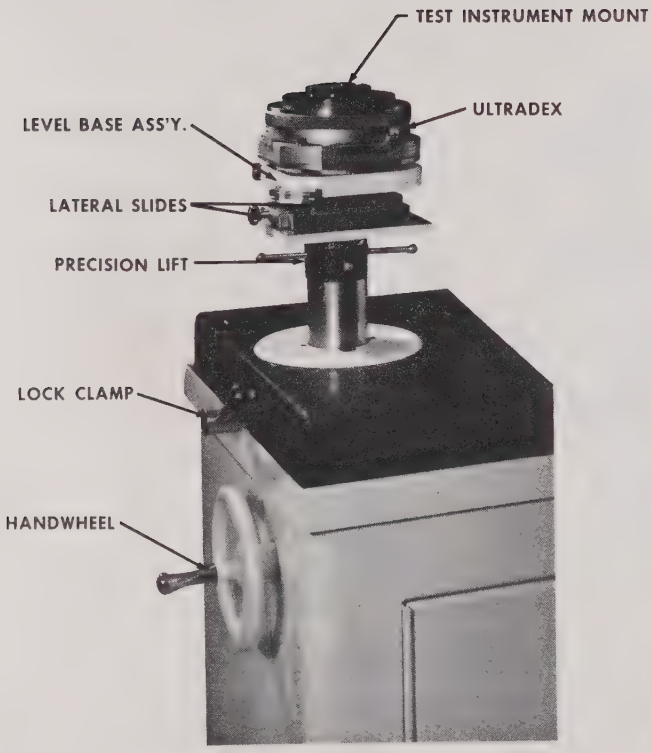
The Granite Base Plate provides the medium by which the Test Post and Target Post are assembled into a complete unit. The rigidity and mass of this unit maintains the alignment of the two posts and, to a degree, dampens vibrations which would otherwise be transmitted to the posts.

B. Test Post Description

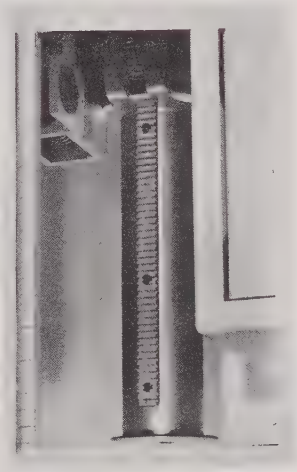
The Test Post (see fig. 3) consists of an upper and lower portion. The lower portion, or Lift Stand Assembly, provides for major incremental height changes and is controlled by a removable hand-wheel and lock clamp at the front* end of the Cabinet. A unique worm drive gearbox prevents the Test Post from dropping, even when left unclamped. Beginning with serial number 11, the lower Test Post may also be equipped with an Optical Plummet Collimator. The Optical Plummet Collimator position may be adjusted by two external control knobs located at the front end of the Cabinet. The upper portion of the Test Post receives the test instrument and provides continuous adjustment of the test instrument position relative to the Target Post.

The test instrument is mounted to the indexing table by one of several mounts provided. The Calibrator is equipped with a basic 3-1/2-8 male threaded mounting plate which is centered with respect to the rotational axis of the indexing table. This mount will accept most American made instruments. The mount will also receive the Brunson Model #88-6 Leveling Base located on the Target Post, or any similar base, so that collimators may be mounted on the Test Post. Three mounting plate adapters are provided which can be screwed onto this mount to allow mounting of most foreign made

* Throughout this manual, front shall refer to the end of the Cabinet nearest the operator as he views the Target Post from the Test Post. Accordingly, right is the side of the Cabinet that has doors.



LIFT STAND ASS'Y.
(LOWER TEST POST)



TEST POST

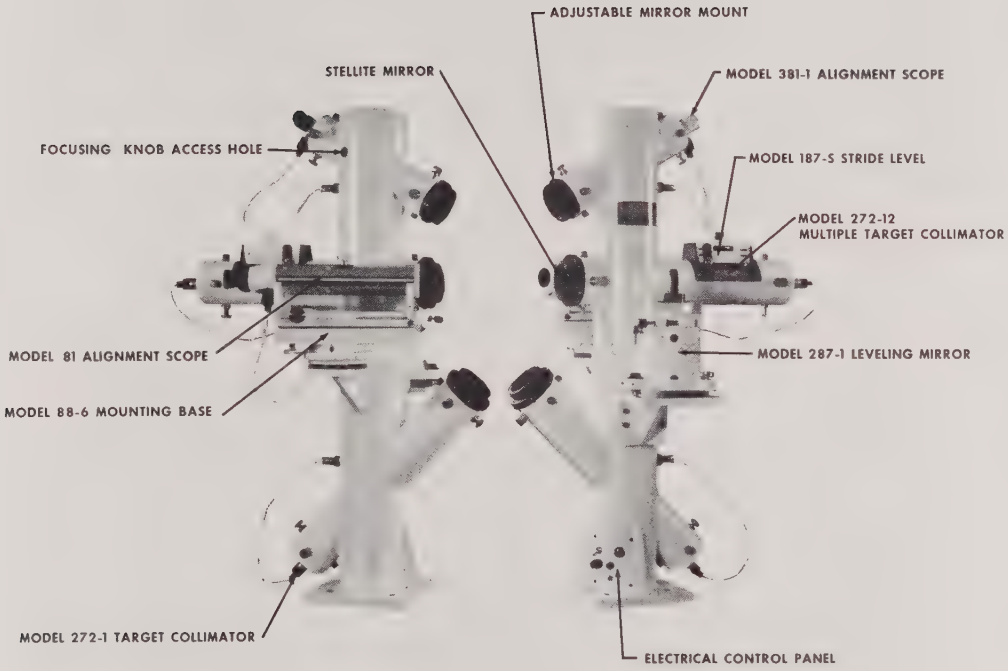
fig. 3

instruments. Also included is an Alidade mounting plate which may be secured directly to the indexing table after removal of the standard 3-1/2-8 threaded mount (see fig. 21, page 66).

Located directly beneath the indexing table is the Level Base Assembly. This unit provides rotational (azimuth) movement of the indexing table about the vertical axis of the Test Post and also provides for leveling of the indexing table. Below the Level Base Assembly is a pair of precision lateral slides which provide longitudinal and transverse adjustment of the Level Base-indexing table assembly. Supporting the entire assembly is a Precision Lift which provides three quarters of an inch of continuous height adjustment of the entire upper Test Post.

C. Target Post Description

The Target Post (see fig. 4) supports two collimators, (Model #272-1 Target Collimator and Model #272-12 Multiple Target Collimator) and two alignment scopes (Model #81 and Model #381-1 Alignment Scope) used as targets when calibrating an instrument. The Model #272-12 Multiple Target Collimator (MTC) located in the horizontal tube provides targets at focusing positions equivalent to distances of 4, 6, 16, 25, 50, 75 feet and infinity. The Model #272-1 provides an infinity target only. The Model #81 and Model #381-1 are used primarily as infinity target collimators, however, they are equipped with auto-



TARGET POST

fig. 4

reflection targets for extreme short focus checks. The MTC and the Model #272-1 Target Collimator (TC) are fixed focus instruments. The Model #81 Alignment Scope (AS 1) and the Model #381-1 Alignment Scope (AS 2) are variable focus instruments and may be used as line scopes or collimators. They also possess auto-collimation and auto-reflection capabilities. The AS 1 located on the side of the Target Post is mounted in a removable Model #88-6 Leveling Base which provides limited continuous adjustments of the alignment scope position in both the vertical and horizontal planes.

Lighting attachments for these instruments plug directly into the Target Post. Illumination level is adjusted by the electrical control panel at the base of the Target Post. Lighting for the Optical Plummet Collimator is also controlled by this panel. The off and on switch controls power to all the Calibrator instruments.

Adjustable mirror mounts for the magnetic base Model #185 Stellite mirrors are located on the objective end of the three Target Post instrument mounting tubes. This allows checking of an instrument by auto-collimation and auto-reflection techniques, if the test instrument is so equipped.

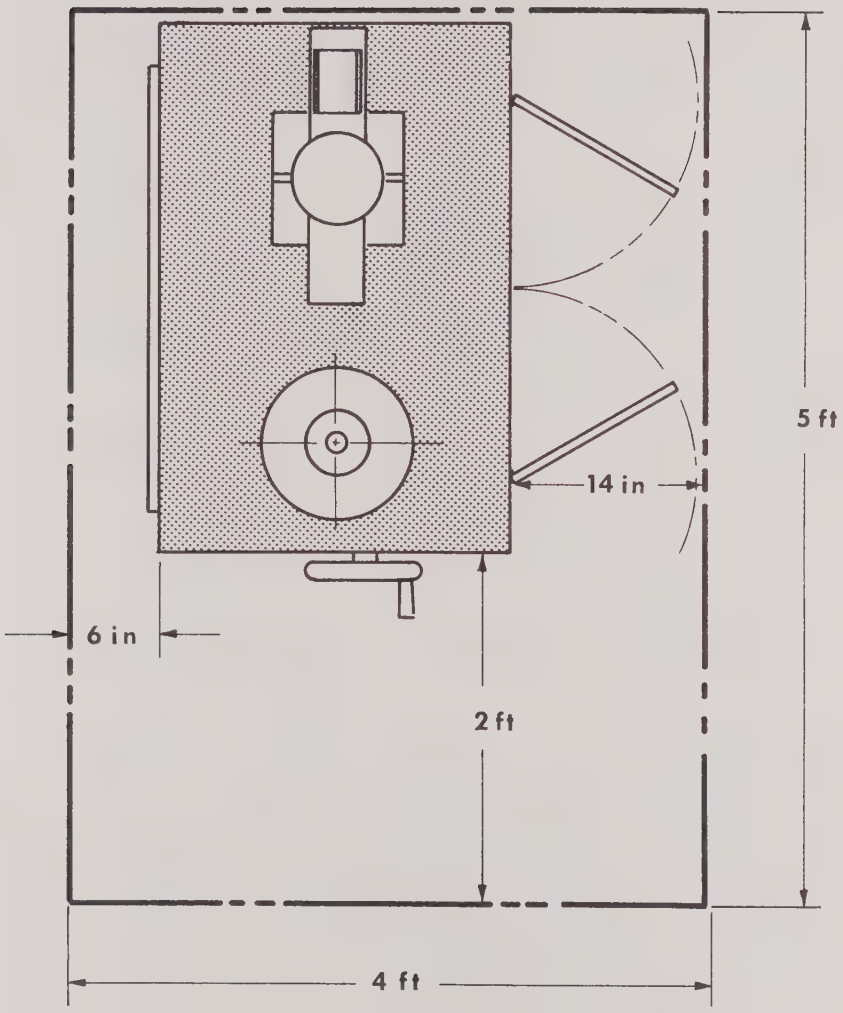
INSTALLATION

IV. INSTALLATION

The complete Universal Short Range Calibrator is shipped in one crate and one wooden box. The shipping containers should be carefully inspected for evidence of shipping damage. If damage is suspected take pictures, if possible, and contact the freight line responsible to assure prompt processing of a damage claim.

If it is intended that your Universal Short Range Calibrator be placed in an area of restricted size, please consider figure five before proceeding. Figure five shows the minimum recommended area that the USRC may be placed in and still provide sufficient room for comfortable operation of the Calibrator. There should be six inches between the 110 volt outlets and any wall or obstruction to allow easy access to the outlets when electrical power is required by the test instrument. There should be at least fourteen inches between the right side of the Cabinet and any wall or obstruction to allow the Cabinet doors to be opened. All other dimensions are governed by operator comfort only and are at the discretion of the user.

CAUTION: Before proceeding please note that the two shipping cases are quite heavy. Use mechanical handling equipment only.



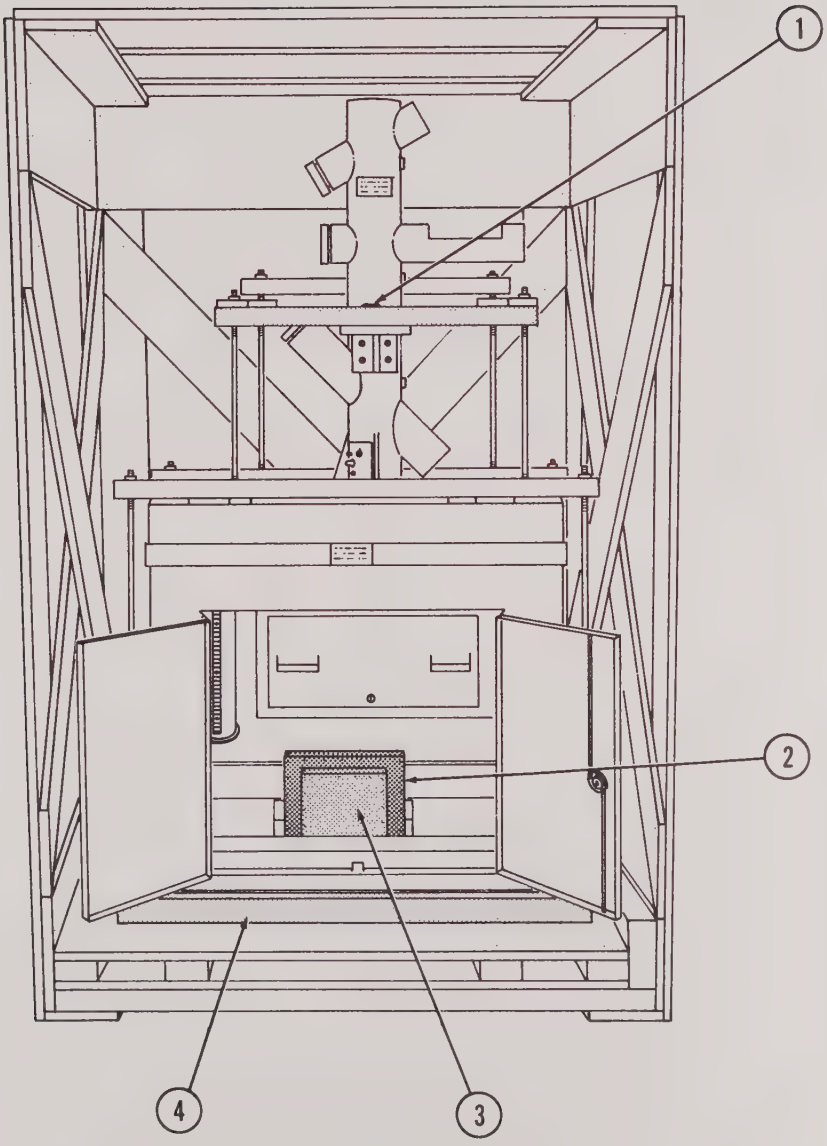
MINIMUM FLOOR SPACE

fig. 5

A. Unpacking and General Assembly

1. Place the large crate so that the Cabinet doors are facing an area in which a fork lift can be operated.
2. Remove the screws holding this crate side to the remainder of the crate.

   NOTE: There are screws into this side through the top. BE SURE they are removed.
3. Remove the crate side and the 2" Fiberglas cushion at the base which is now free.
4. The Calibrator is palletized and may now be removed by use of the fork lift, or other mechanical lifting device.
5. If necessary to conserve storage space, the top and remaining sides of the shipping crate may be separated since they are held together by screws.
6. Remove the polyethelene film used to protect the Calibrator from dirt, grease, etc., during shipping. The keys to the Cabinet door and inner drawer will be found in an envelope taped to the upper "hold down" block above the door. (See fig. 6, no. 1.)
7. Unlock and open the Cabinet door. The Ultradex and the Adjusting Devices Assembly will be found inside the Cabinet packed in separate wooden boxes. Remove these boxes. (See fig. 6, no. 2 & 3.) Unlock the drawer and remove all accessories that are in it. Close and latch the Cabinet doors.



CALIBRATOR IN SHIPPING CRATE

fig. 6

8. Remove the "hold down" blocks and the threaded studs that hold them to the pallet.

9. Remove the two lag bolts holding the 2 x 4 that passes under the Cabinet doors and slide the 2 x 4 out from under the doors. (See fig. 6, no. 4.)

10. The Cabinet and the assemblies mounted on it may now be removed from the pallet. It is recommended that the unit be lifted from the end of the pallet. This will facilitate movement of the unit through doors etc. If transportation to the use area by fork lift is impractical or impossible, the complete unit may be placed on a sturdy moving device such as a piano dolly.

    NOTE: This assembly is top heavy . Extreme care must be exercised when moving it into position to prevent toppling.

11. When the Calibrator is in position, place the rest pads on the floor, release the jam nuts, extend the leveling screws and lower the Calibrator onto the pads.

    NOTE: To extend the leveling screws, open the cabinet doors and remove the false bottom from the Cabinet. A female 1/2" square drive socket on an extension is recommended for turning the screws but a 1/2" open end wrench may be used.

12. The Granite Base Plate is supported by leveling screws during normal use. Additional screws are used for security during shipment. Prior to leveling the Cabinet the extra screws must be turned out of contact with the Granite Base Plate. To obtain access to the screws to be backed off, remove the Cabinet drawer.

    On all units, the screw through the center rail directly under the Target Post should be released. On USRC 11 and on, the two outer screws of the three at the rear end of the base must be released also.

13. Place a sensitive level on the Base Plate and, using it as a reference, level the Cabinet in both planes. The Base Plate has been previously set after the Cabinet was leveled, so leveling the plate levels the Cabinet.

14. Obtain the Adjusting Devices Assembly and its mounting screws from their shipping box. Position the assembly so that the knob controlling the longitudinal motion is toward the operator's position and secure with the screws.

    Place one of the Model #185 mirrors on the Base Plate so that the tapped holes in the Adjusting Devices Assembly can be seen through the mounting plate holes to aid in locating the assembly.

15. Obtain the Ultradex and its mounting screws and washers from their shipping box. Mount the Ultradex on the Level Base Assembly using the screws and washers. The Ultradex handle is to be located on the right side.

16. Obtain the extension cord and plug the polarized connector into the receptacle on the left rear side of the Cabinet. This completes the mechanical installation of the Universal Short Range Calibrator.

B. Installation of Collimators and Accessories

1. Open crate 2 and remove the boxes and cases inside. Place the boxes and Fiberglas cases so that the nameplates can be read.

NOTE: All collimators and accessories should be checked prior to installation in or on the Target Post. See the appropriate section for information on accomplishing these checks. (See fig. 4, page 8.)

2. Back off the four adjusting screws opposite the spring loaded plungers in the lower angled tube. These should be backed out until the rounded tip inside the tube is nearly flush with the inside wall of the tube. Remove the Mirror Mounting Assembly from the front end of the tube.

3. Open the Fiberglas case containing the Model #272-1 Target Collimator.

4. Note the four flat portions of the two mounting rings on the ends of the collimator barrel. These flat portions will be horizontal and vertical when the installation is complete. Insert the collimator, eyepiece end first, from the front end of the Target Post tube. The barrel should be rotated 45^{o} from its final position while

this is being done to assure that the reticle adjusting capstan screws do not contact the adjusting screws or plunger tips as the collimator is inserted.

5. When the collimator is in approximate position, rotate it 45° and bring the ring at the eyepiece end of the collimator into contact with the spring loaded plungers at the rear end of the tube. The collimator may be supported by the eyepiece during this operation. Screw in the previously "backed out" adjusting screws and center the rear end of the collimator in the tube by eye.
6. Support the objective end of the collimator in contact with the spring loaded plungers at the front end of the tube and screw in the adjusting screws, centering this end of the collimator in the tube by eye.
7. Remove the lighting attachment from the Fiberglas case. Install the male connector on the bottom receptacle on the post, and snap the lighting attachment onto the eyepiece.
8. Reinstall the Mirror Mounting Assembly at the front end of the collimator tube. Installation of the Model #272-1 Target Collimator is now complete.

9. Remove the two lower adjusting screws from the horizontal tube and back out the adjusting screws and spring plungers at both ends of the tube. Remove the Mirror Mounting Assembly. Place a strip of

heavy paper approximately 3" wide by 20" long along the bottom of the tube. This prevents scratching the barrel of the collimator when sliding it into position within the tube.

10. Remove the Model #272-12 Multiple Target Collimator from its Fiberglas carrying case.

11. Approximately 5-1/2" along the barrel of the collimator from the objective end will be found 3 slots 120° apart. These slots are for focusing lens adjustment (see fig. 7, page 31). Place the collimator barrel in the tube so that the slot which lines up with the reticle adjusting slots is in the up position and slide the collimator into the tube on the paper. Slide the collimator into the tube from the front end of the tube until the objective end of the collimator barrel is flush with the front end of the tube.

12. With the collimator completely into the tube, carefully lift the eyepiece end of the collimator and move the paper forward so it will be out of the way of the lower adjusting screw. Reinstall this screw and tighten the spring plunger screws. Use the two adjusting screws at the eyepiece end of the horizontal tube to center the collimator barrel within the tube by eye.

13. Lift the objective end of the collimator barrel and remove the paper. Reinstall the lower adjusting screw and tighten the spring plunger screws. Use the adjusting screws to center the collimator barrel in the tube by eye. Reinstall the Mirror Mounting Assembly.

14. Remove the lighting attachment from the Fiberglas carrying case and install on the eyepiece. Install the male plug on the female socket at the center rear of the Target Post. Installation of the Model #272-12 Multiple Target Collimator is now complete.

15. Back out the adjusting screws and the horizontal spring plungers in the upper, angled collimator tube.

16. Open the wooden box containing the Model #381-1 Alignment Scope. Remove the instrument and the adapter tube from the box. Screw the adapter tube into the objective end of the barrel. (See fig. 11, page 46.)

17. Stand facing the right side of the Target Post and insert the adapter end of the Model #381-1 into its tube from the rear. Be sure that the focusing knob is facing away from you.

18. Slide the collimator into the tube until the slotted focusing knob is centered in the hole through the left side of the Target Post.

19. Tighten the adjusting screws until the collimator is secured at the front and rear end. When the collimator is secured, use the adjusting screws to center the collimator in the tube and check to see that the slot in the focusing knob is centered in the post opening.

20. Obtain the lighting attachment and connect the male plug to the socket on the post. The adapter that screws into the collimator right angle eyepiece has a four lead thread. Rotate the adapter counterclockwise in contact with its receptacle on the collimator

until the threads "drop-in", the adapter may then be turned clockwise to screw into the receptacle without damaging the threads. Installation of the Model #381-1 Alignment Scope is now complete.

21. Remove the Model #88-6 Mounting Base from its wooden carrying case. Use a 3/16" Allen wrench to loosen the two socket set screws in the mounting plate until the upper assembly will lift out of the mounting plate socket.
22. Screw the mounting plate onto the mounting ring on the side platform. The upper portion of the Model #88-6 may be re-inserted in its socket and the socket head set screws lightly tightened into contact with the plug on the lower portion of the base assembly.
23. Obtain the Model #81 Alignment Scope from its Fiberglas carrying case and place in the vees of the Model #88-6 base. Screw the lighting attachment into its receptacle on the eyepiece adapter of the Model #81 and connect the male plug to its receptacle on the Target Post. Installation of the Model #81 Alignment Scope is now complete.

24. Remove the Model #287-1 Leveling Mirror and base from its carrying case.
25. Use a screwdriver or coin to remove the upper fill plug from the Leveling Mirror reservoir. Use the mineral oil provided in the

plastic squeeze bottle to fill the reservoir. Replace the plug.

26. Place the Leveling Mirror in its base. Place the base on the adjustable platform and level using the bulls-eye bubble as reference. Installation of the Model #287-1 is now complete.

27. Remove the Model #187-S Stride Level and its elastic hold down strap from its wooden case.

28. Pass the hold down strap under the Multiple Target Collimator barrel in the horizontal collimator tube and mount the Model #187-S on the collimator barrel. Secure with hold down strap. This completes the installation of the collimators and accessory units.

V ALIGNMENT OF COLLIMATORS IN THE CALIBRATOR

1. Obtain a transit-type instrument hereafter called the test instrument or TI and mount it on the Test Post. (An optical tooling type transit is preferred to allow for aligning to closest virtual target of 4 ft.)

2. Accurately level the TI and verify that the reticle is oriented to vertical. (Use plumb line or traverse and plunge through a point.)

3. Focus the TI to infinity. Turn on Test Post lighting system and observe the rotational relationship of the Multiple Target Collimator (MTC) infinity reticle image with the TI reticle image. Rotate the MTC until the two images are parallel to each other. Level the MTC using the

Model #187-S Stride Level. Bring the two reticle images into register using the horizontal (azimuth) tangent screw and the vertical (zenith) tangent screw of the TI.

4. Verify visually that the MTC is centered in its tube and "buck-in" the TI on the infinity and shortest range virtual target image of the MTC which you can see.

5. Plunge TI telescope to view infinity reticle of Model #272-1 Target Collimator in lower inclined tube. Rotate collimator barrel to bring collimator reticle pattern parallel to TI reticle pattern. Use the collimator adjusting screws to bring collimator reticle image into register with TI reticle image.

6. Plunge TI telescope to view reticle of Model #381-1 Alignment Scope in upper angled tube of Target Post. Rotate Alignment Scope to make reticle images parallel. Use the collimator adjusting screws to bring reticle images of TI and Alignment Scope into register.

NOTE: It may be necessary to focus the Model #381-1 to infinity after installation in Target Post. Insert a screwdriver through the hole on the left side of the angled tube and rotate focusing knob all the way counterclockwise. Then, while observing in the TI use the screwdriver to rotate the focusing knob slowly clockwise until a clear sharp image of the filar-bi-filar reticle pattern of the Model #381-1 appears.

7. Reverse the TI on its own vertical and horizontal axis and set to Target Collimator reticle (lower tube).
8. Plunge to Alignment Scope (upper tube) and if there is any error detected in the register of the reticle images correct one quarter of the apparent error by using the collimator adjusting screws.
9. Plunge to MTC (horizontal tube). Use horizontal tangent screw of TI to bring reticle images into register if necessary.
10. Rotate Ultradex eighteen degrees.

    NOTE: ON USRC 01 thru 10, rotate Ultradex C. C. W.

    On USRC 11 and subsequent rotate Ultradex C. W.
11. Use the Model #88-6 Mounting Base tangent screws to bring the reticle images of the Model #81 Alignment Scope and the TI into register.

    NOTE: It may be necessary on original installation to loosen the two socket head set screws that secure the upper part of the #88-6 to the mounting plate and rotate the entire upper assembly so that the tangent screws may be used in their mid-range.
12. This completes the Target Post collimator alignment. Further refinement or touch up of the alignment should be made during use of the Calibrator.
13. On Calibrators equipped with an Optical Plummet Collimator (OPC) it is necessary to correctly position the OPC before it is used for calibration.

14. Obtain a theodolite that has an optical plummet that rotates with the standard, such as: Hilger Watts, Kern, etc. Screw the appropriate mount on the Test Post to receive the theodolite.
15. Mount, and accurately level, the theodolite on the Test Post.
16. Look into the optical plummet eyepiece and focus to obtain the image of a target in the OPC. (There are three targets in the OPC at equivalent distances of 6 ft., 16 ft., and infinity.)
17. While observing the optical plummet reticle and the OPC target image, use the lateral slides to position the theodolite so that the reticle and target patterns come into register.
18. Rotate the theodolite 180^{o}. Any error in reticle and target pattern register must be removed.
19. Locate the two knobs labeled X and Y located at the operator's end of the Cabinet. These are the OPC axis control knobs.
20. While observing the reticle and target patterns, use the OPC axis control knobs to remove one half the register error between the reticle and target images.
21. Rotate the theodolite 180^{o}. If out of register condition still exists then the optical plummet of the theodolite needs adjustment.
22. While observing the reticle and target patterns, adjust the optical plummet of the theodolite to remove one half the register error.
23. Rotate the theodolite 180^{o}. If out of register condition still exists repeat steps 20 thru 22 until all error is removed.
24. Alignment of the OPC is now complete.

VI. GENERAL OPERATING PROCEDURES

It is not within the scope of this manual to provide operating procedures to test every commercially available instrument. Since books are available on the subject of instrument adjustment and calibration, we believe that the uninitiated would be best served by referring to such books. Once the general procedures are understood they may be applied to the job at hand.

There are, however, a few simple steps that should be followed when setting up any instrument for testing. Always keep in mind that the Calibrator must be correctly aligned before any instrument may be correctly tested. (See section V, Alignment of the Collimators in the Calibrator.) Once the Calibrator has been aligned, do not adjust the positions of any of the target instruments. When aligning the test instrument (TI) with any of the targets, adjust the position of the TI only, by using the adjustments provided beneath the Ultradex and the tangent and leveling adjustments provided on the TI itself. The following steps will aid in testing all types of instruments.

1. Determine what type of adapter, if any, is required to mount the TI to the Test Post. Mount the necessary adapter. When the Alidade plate is required, simply unscrew the three screws securing the standard 3-1/2 -8 threaded mount to the Ultradex and remove the mount. The Alidade plate may then be attached to the Ultradex using the three screws. When alignment scopes are to be checked, the Model #88-6 Mounting Base may be removed from the Target Post and placed on the Test Post

to receive the TI. If a mount similar to the Model #88-6 is readily available, it may be convenient to use it on the Test Post in applications where repeated disassembly of the Model #88-6 from the Target Post would be time consuming.

2. Mount the TI on the Test Post and plug any lighting attachment which may be needed into the outlets on the side of the Cabinet.
3. If necessary, release the lock clamp and use the handwheel to adjust the height of the TI until it is approximately at the same height as the MTC. Use the lock clamp to secure the Test Post.

NOTE: Although the Test Post will not drop when left unclamped it is not stable enough to permit accurate testing of the TI when in this condition.

To achieve the critical height adjustment necessary to align the TI reticle image with that of the target use the precision lift to control precise height adjustments. Final height adjustment should be made with the TI carefully leveled.

4. When transit or theodolite circles are to be checked make certain that the Ultradex is leveled to within thirty seconds of true horizontal. For most other applications leveling of the Ultradex is not critical.
5. When transits or theodolites are to be checked by auto-collimation techniques, install the three Model #185 Stellite mirrors on their adjustable mounts on the Target Post.

6. When auto-reflection and/or auto-collimation checks are to be made on any type of instrument, install one Model #185 Stellite mirror on its adjustable mirror mount on the front end of the MTC mounting tube.

7. When the optical plummet of a theodolite is to be checked (this is possible only on Calibrators equipped with an Optical Plummet Collimator) use the precision slides to position the TI over the Optical Plummet Collimator. Do not use the axis control knobs located at the operator's end of the Cabinet to adjust the Optical Plummet Collimator position.

VII FUNCTIONAL TEST PROCEDURES

A. Introduction

The heart of the Universal Short Range Calibrator is its collimator system. On USRC 01 thru 10 there are two collimators and two alignment scopes that serve as collimators. On USRC 11 and subsequent there may be three collimators, the third being used to check optical plummets. The two Alignment Scopes (Models #81 and #381-1) and the Model #272-1 Target Collimator are normally used as infinity targets only. Nominally, the only check required of these collimators is to verify the infinity focus.

The Model #272-12 Multiple Target Collimator should be checked periodically to verify that the infinity target is at infinity and all targets are centered on the optical and mechanical axis of the collimator barrel. ON USRC 11 and subsequent the Optical Plummet Collimator should be checked in the same manner as the Model #272-12.

Other items that should be checked periodically are the Model #187-S Stride Level and the Model #287-1 Leveling Mirror. The Levveling Mirror should be checked more often than the other components to assure verticality of the mirror.

Components such as mirrors, lights, adapters, etc., normally require checking only upon initial receipt and from then on only when there is reason to question their accuracy or capability of functioning as required to check instruments.

The Ultradex indexing table should be returned to a calibration laboratory once a year for the first two years of operation of the Universal Short Range Calibrator. Comparison of the data obtained at the recalibration times with the data from the original acceptance may then be used to predict and establish the recalibration interval since the interval depends on many factors such as amount of use, atmospheric conditions etc.

B. General Procedures for Calibration of Collimators

Calibration of the Universal Short Range Calibrator's collimators is most conveniently accomplished on a surface plate. The Model #81 Alignment Scope located on the side mount of the Target Post is an ideal instrument to use when calibrating or checking the Models #272-12, #272-1 and the Optical Plummet Collimator. The Model #81 may in turn be checked using the Model #272-12 Multiple Target Collimator. If all collimators are to be checked at one time follow the sequence of checks as it is listed. If only one collimator is to be checked then refer to the instructions for that collimator. The provision of supplemental equipment such as, vee blocks, instrument stands, etc., necessary to perform these checks is the responsibility of the using facility.

In checking any collimator the following general procedures should be observed.

1. The center lines of the collimator being checked and the viewing instrument should be coincident within one tenth inch or less.

2. The vee blocks used to support the unit being checked should be placed as nearly as possible so that the unit is supported in the same area as it is in the stand.
3. When rolling an instrument only comparison of vertical wire image with vertical wire should be used. DO NOT attempt to determine horizontal wire displacement.
4. Use only the filar portion of a filar-bifilar pattern, as the bifilar portion may not be exactly centered with respect to the filar portion.
5. When minor adjustments to the Model #272-1 and #272-12 collimators are required (five seconds or less), adjust the reticle using only the adjusting screw that "pulls" the reticle in the direction it looks like it needs to be moved. Experience indicates that this method, as opposed to the loosening-tightening method, results in stabilization of the setting in a shorter period of time.
6. If adjustment of the reticle position of the Model #81 or #381-1 Alignment Scope is required the loosening-tightening method is necessary to prevent "double centering" the barrel. Adjustment is made by "pushing" the reticle in a direction opposite to the way it appears to need to be moved.

NOTE: The adjusting screws of these instruments do not thread into the reticle mounts as they do on the Model #272-1 or #272-12.

C. Calibration of the Model #272-12 Multiple Target Collimator

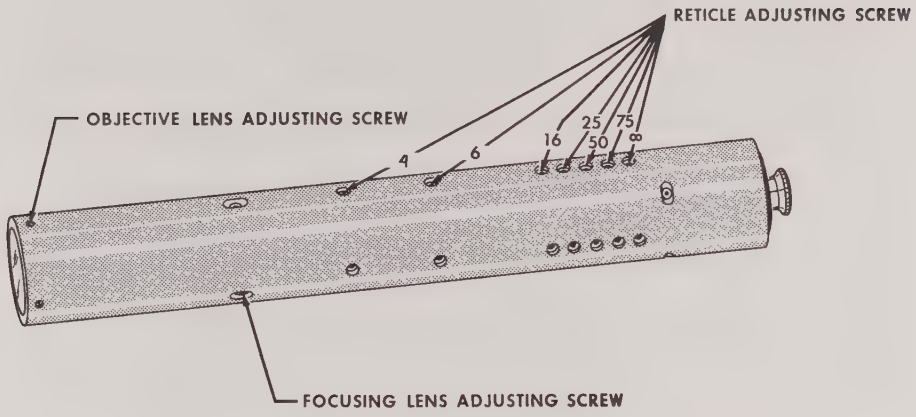


fig. 7

1. Remove the Model #272-12 Multiple Target Collimator (hereafter referred to as the MTC) from the Target Post. Use the reverse of steps 11 thru 14 of the Collimator Installation Procedure, page 18.
2. Place the MTC in vee blocks on a surface plate.
3. Rotate the MTC until the focusing lens adjusting screw slot which is in line with the reticle adjusting screw slots is on top.
4. Attach the separate auxiliary lighting unit (shipped in the Fiberglas carrying case for the MTC) to the MTC. Turn on light.
5. Position the Model #81 Alignment Scope (hereafter referred to as the AS 1) in the Model #88-6 or similar mounting base on the surface plate so that the AS 1 is looking into the MTC. If the Model #88-6 base is used refer to steps 21 and 22 of the collimator installation procedure and reverse them for removal of the base from the Target Post.

6. Attach the separate auxiliary lighting unit (shipped in the Fiberglas box containing the AS 1) to the AS 1. Turn on light.
7. Use one of the Model #185 Stellite mirrors to verify that the AS 1 is focused for infinity by auto-collimating off the mirror. If the reflected image is not in clear focus, turn the focusing knob until the image becomes sharp and distinct. The AS 1 is now focused to infinity. Turn off light.
8. Position the two collimators until the infinity reticle image of the MTC is in vertical and horizontal register with the reticle image of the AS 1.
9. If the infinity reticle image of the MTC is sharp and distinct proceed to step 11. If it is not the focusing lens of the MTC must be adjusted.
10. Loosen the three focusing lens adjustment screws (see fig. 7). Carefully slide the focusing lens back and forth until the infinity reticle image of the MTC comes into sharp focus. Snug the three adjusting screws and verify that the infinity reticle image is still in sharp focus.

CAUTION: Do not overtighten the screws.

11. Rotate the MTC 180° in its mount. Check for out of register condition of vertical wire images only. If out of register condition is present remove one half the apparent error using the horizontal cap

screws located toward the eyepiece end of the MTC. Remove the remaining error by using the tangent screws of the mount supporting the AS 1.

12. Rotate the MTC 180° in its mount and verify the adjustment. Continue rotating 180° and adjusting until the vertical wires remain in register.
13. Rotate the MTC 90° and using only the adjusting screws of the MTC reticle adjust until the vertical wires are in register.
14. Bring both vertical and horizontal patterns into register and again rotate the MTC 180°. If the adjustment is complete, the wires should remain in exact register both vertically and horizontally. If they do not, rotate the MTC 90° and repeat steps 8 thru 13 until they remain in register.
15. Adjust each of the remaining reticles in the same manner as the infinity reticle by focusing the AS 1 to receive the image of each of the remaining reticles.
16. When the calibration is complete return the MTC to the Target Post.

NOTE: For best results, calibration of the Model #187-S Stride Level should be carried out on the instrument on which it is used. Since correct calibration requires removal of the MTC from the Target Post it is advisable to calibrate the Stride Level at this time. Proceed to the appropriate section if desired.

17. If either the Model #272-1 Target Collimator or the Optical Plummet Collimator is to be checked leave the AS 1 in its mount on the surface plate and proceed to check the appropriate instrument. If not, return the AS 1 (and Model #88-6 base) to its position on the Target Post.

D. Calibration of the Model #272-1 Target Collimator

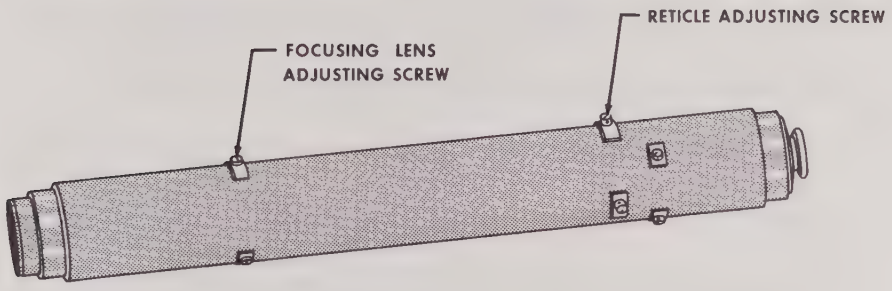


fig. 8

1. Remove the Model #272-1 Target Collimator (hereafter referred to as the TC) from the Target Post. Use the reverse of steps 4 thru 8 of the Collimator Installation Procedure, page 16.
2. Remove the mounting rings at the objective and eyepiece end of the collimator. Note their positions so that they may be replaced in the same relative positions when the calibration is complete.
3. Place the TC in vee blocks on a surface plate. Support it only on the two ground rings from which the mounting rings were removed.
4. Rotate the TC until the focusing lens adjusting capstan screw which is in line with the reticle adjusting capstan screw is on top.
5. Attach the separate auxiliary lighting unit (shipped in the Fiberglas carrying case for the TC) to the TC. Turn on light.

6. Position the Model #81 Alignment Scope (hereafter referred to as the AS 1) in the Model #88-6 or similar mounting base on the surface plate so that the AS 1 is looking into the TC. If the Model #88-6 base is used refer to steps 21 and 22 of the Collimator Installation Procedure for removal from the Target Post.
7. Attach the separate auxiliary lighting unit (shipped in the Fiberglas carrying case containing the AS 1) to the AS 1. Turn on light.
8. Use one of the Model #185 Stellite Mirrors to verify that the AS 1 is focused for infinity, by auto-collimating off the mirror. If the reflected image is not in clear focus, adjust the focusing knob until the image becomes sharp and distinct. The AS 1 is now focused to infinity. Turn off light.
9. Position the two collimators until the infinity reticle image of the TC is in vertical and horizontal register with the reticle image of the AS 1.
10. If the infinity reticle image of the TC is sharp and distinct proceed to step 12. If it is not the focusing lens of the TC must be adjusted.
11. Loosen the three focusing lens adjustment screws (see fig. 8). Carefully slide the focusing lens back and forth until the infinity reticle image of the TC comes into sharp focus. Snug the three adjusting screws and verify that the infinity reticle image is still in register with the AS 1 reticle.

    CAUTION: Do not overtighten the screws.

12. Rotate the TC 180° in its mount. Check for out of register condition of vertical wire images only. If out of register condition is present remove one half the apparent error using the horizontal capstan screws located toward the eyepiece end of the TC. Remove the remaining error by using the tangent screws of the mount supporting the AS 1.
13. Rotate the TC 180° in its mount and verify the adjustment. Continue rotating 180° and adjusting until vertical wires remain in register.
14. Rotate the TC 90° and using only the adjusting screws of the TC reticle adjust until the vertical wires are in register.
15. Bring both vertical and horizontal patterns into register and again rotate the TC 180°. If the adjustment is complete, the wires should remain in exact register both vertically and horizontally. If they do not, rotate the TC 90° and repeat steps 9 thru 14 until they remain in register.
16. When the calibration is complete, replace the two mounting rings and return the TC to the Target Post.
17. If the Optical Plummet Collimator is to be checked leave the AS 1 in its mount on the surface plate and proceed to the next section.
18. If the AS 1 is to be checked proceed to the appropriate section.

E. Calibration of the Optical Plummet Collimator

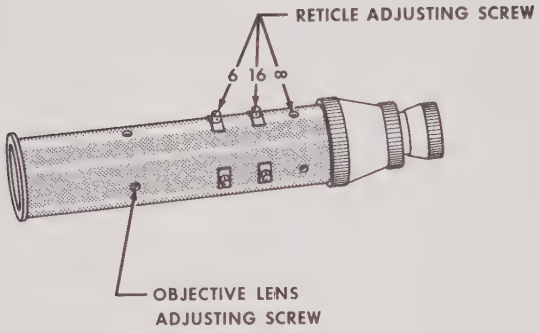


fig. 9

1. Remove the Optical Plummet Collimator (hereafter referred to as the OPC) from the bottom of the Test Post. See Maintenance instructions page 57, steps 1 thru 15.
2. Loosen the two set screws and remove the axis ring. Note its position before removal so that it may be replaced in the same position.
3. Place the OPC in vee blocks on the surface plate.
4. Attach the separate auxiliary lighting unit that comes with the Model #381-1 Alignment Scope to the OPC. Turn on light.
5. Position the Model #81 Alignment Scope (hereafter referred to as the AS 1) in the Model #88-6 or similar mounting base on the surface plate so that the AS 1 is looking into the OPC. If the Model #88-6 base is used refer to steps 21 and 22 of the Collimator Installation Procedure for removal from the Target Post.

6. Attach the separate auxiliary lighting unit (shipped in the Fiberglas carrying case containing the AS 1) to the AS 1. Turn on light.
7. Use one of the Model #185 Stellite mirrors to verify that the AS 1 is focused for infinity, by auto-collimating off the mirror. If the reflected image is not in clear focus, adjust the focusing knob until the image becomes sharp and distinct. The AS 1 is now focused to infinity. Turn off light.
8. Adjust the two collimators until the infinity reticle image of the OPC is in vertical and horizontal register with the reticle image of the AS 1.
9. The infinity reticle image of the OPC should be sharp and distinct. (If it is not, either the objective lens or the infinity reticle has been moved due to mishandling. The OPC should be returned to the factory for repair.)
10. Rotate the OPC 180° in its mount. Check for out of register condition of vertical wire images only. If out of register condition is present remove one half the apparent error using the horizontal set screws located toward the eyepiece end of the OPC. Remove the remaining error by using the tangent screws of the mount supporting the AS 1.
11. Rotate the OPC 180° in its mount and verify the adjustment. Continue rotating 180° and adjusting until vertical wires remain in register.
12. Rotate the OPC 90° and using only the adjusting screws of the OPC reticle adjust until the vertical wires are in register.

13. Bring both vertical and horizontal patterns into register and again rotate the OPC 180°. If the adjustment is complete, the wires should remain in exact register both vertically and horizontally. If they do not, rotate the OPC 90° and repeat steps 8 thru 13 until they remain in register.

14. Adjust the two remaining reticles using the capstan adjusting screws in the same manner as the infinity reticle by focusing the AS 1 to receive the image of each of the remaining reticles.

15. When the calibration is complete return the OPC to the Test Post.

16. If the AS 1 is to be checked proceed to the next section. If not, return the AS 1 (and #88-6) to the Target Post.

F. Calibration of the Model #81 Alignment Scope.

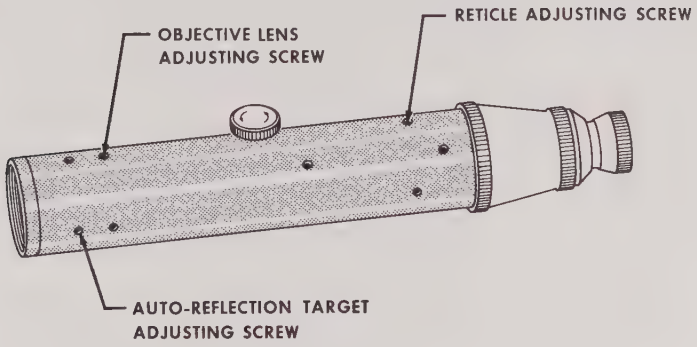


fig. 10

1. Remove the Model #81 Alignment Scope (hereafter referred to as the AS 1) from the Target Post.
2. Secure the Model #88-6 or similar mount to the Test Post.
3. Place the AS 1 in the mount so that the objective end is pointed toward the Model #272-12 Multiple Target Collimator (MTC).
4. Adjust the eyepiece of the AS 1 until the reticle becomes sharp and distinct.
5. Place a Model #185 Stellite mirror on the adjustable mirror mount in front of the MTC.
6. Attach the separate auxiliary lighting unit (shipped in the Fiberglas carrying case for the AS 1) to the AS 1. Plug the lighting unit into the external outlets on the side of the Cabinet. Turn on light.

7. Focus the AS 1 to infinity by auto-collimating off the mirror. Adjust the focusing knob until the reflected image of the reticle comes into sharp focus. The AS 1 is now focused to infinity. Turn off light. Remove Model #185 Stellite mirror from Target Post.
8. Turn on the light to the MTC.
9. Use the adjustments provided on the Test Post and the mount supporting the AS 1 to align the AS 1 so that the infinity reticle image of the MTC is in vertical and horizontal register with the reticle image of the AS 1.
10. If the infinity reticle image of the MTC is not sharp and distinct, then the MTC is not properly adjusted and must be corrected before proceeding to the next step. (See procedures for calibration of the Model #272-12 Multiple Target Collimator, page 31.)
11. Rotate the AS 1 180^{o} in its mount. Check for out of register condition of vertical wire images only. If out of register condition exists the reticle of the AS 1 must be adjusted.
12. Use the two horizontal reticle adjusting screws of the AS 1 to remove one half the apparent error. Remove the remaining error by using the tangent screws of the mount supporting the AS 1.
13. Rotate the AS 1 180^{o} in its mount and verify the adjustment. Continue rotating 180^{o} and adjusting until vertical wires remain in register.
14. Rotate the AS 1 90^{o} and using only the adjusting screws of the AS 1 reticle adjust until the vertical wires are in register.

15. Bring both vertical and horizontal patterns into register and again rotate the AS 1 180°. If the adjustment is complete, the wires should remain in exact register both vertically and horizontally. If they do not, rotate the AS 1 90° and repeat steps 9 and 11 thru 14 until they remain in register.

16. If it is not possible to roll in the reticle, the position of the focusing lens relative to the optical-mechanical axis of the scope has been disturbed due to mishandling. The scope must be returned to the factory for adjustment.

17. Adjust the focusing knob of the AS 1 until the image of the four foot reticle of the MTC become sharp and distinct.

18. Adjust the AS 1 until the two reticle images are in vertical and horizontal register.

19. Rotate the AS 1 180° in its mount. Check for out of register condition of vertical wire images only.

20. If out of register condition exists there may be error in the focusing lens and, or, the objective lens positioning. Adjustment of such error is complex and should be referred to the factory for adjustment.

21. The auto-reflection target may now be checked. Always perform the reticle adjustment before attempting to adjust the auto-reflection target.

22. Place a Model #185 Stellite mirror on the adjustable mirror mount in front of the MTC.

23. Turn on light to AS 1.

24. Turn the focusing knob slowly until the auto-reflection target comes into sharp focus. This will occur when the AS 1 is focused to a distance equal to twice the distance of the auto-reflection target to the mirror.

25. Adjust either the mirror or the AS 1 until the reticle image is centered on the cross of the auto-reflection target pattern.

26. Rotate the AS 1 180^{o} in its mount and check for out of register condition of the vertical pattern only. If out of register condition is present remove one half the error using the horizontal auto-reflection target adjusting screws. Remove the remaining error using the tangent screws of the mount supporting the AS 1.

27. Rotate the AS 1 180^{o} in its mount and verify the adjustment. Continue rotating 180^{o} and adjusting until vertical patterns remain in register.

28. Rotate the AS 1 90^{o} and using only the adjusting screws of the AS 1 auto-reflection target adjust until the vertical pattern is in register.

29. Bring both vertical and horizontal patterns into register and again rotate the AS 1 180^{o}. If the adjustment is complete, the patterns should remain in exact register both vertically and horizontally. If they do not, rotate the AS 1 90^{o} and repeat steps 25 thru 28 until they remain in register.

30. The calibration of the Model #81 Alignment Scope is now complete.

31. If the Model #381-1 Alignment Scope is to be checked remove the Model #81 from its mount on the Test Post and proceed to the next section. If the Model #381-1 is not to be calibrated and the Model #88-6 base has been used to support the Model #81 return both to their positions on the Target Post.

G. Calibration of the Model #381-1 Alignment Scope

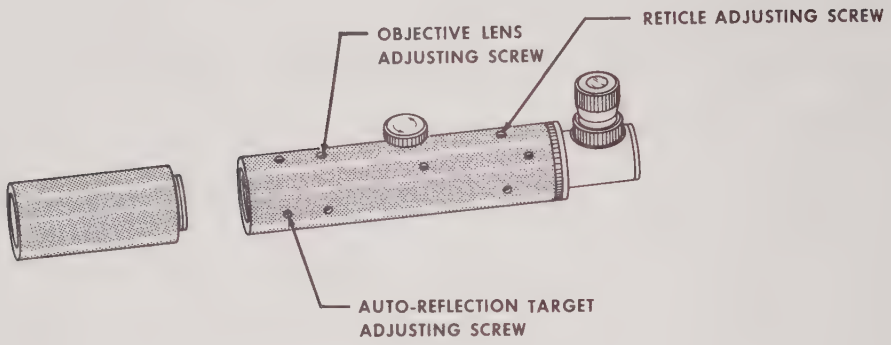


fig. 11

1. Remove the Model #381-1 Alignment Scope (hereafter referred to as the AS 2) from the Target Post. Use the reverse of steps 16 thru 20 of the Collimator Installation Procedure, page 19.
2. Remove the barrel extension at the objective end of the scope by carefully unscrewing it.
3. Secure the Model #88-6 or similar mount to the Test Post.
4. Place the AS 2 in the mount so that the objective end is pointed toward the Model #272-12 Multiple Target Collimator (MTC).
5. Adjust the eyepiece of the AS 2 until the reticle becomes sharp and distinct.
6. Place a Model #185 Stellite mirror on the adjustable mirror mount in front of the MTC.

7. Attach the separate auxiliary lighting unit (shipped in the wooden case for the AS 2) to the AS 2. Plug the lighting unit into the external outlets on the side of the Cabinet. Turn on light.
8. Focus the AS 2 to infinity by auto-collimating off the mirror. Adjust the focusing knob until the reflected image of the reticle comes into sharp focus. The AS 2 is now focused to infinity. Turn off light. Remove Model #185 Stellite mirror from Target Post.
9. Turn on the light to the MTC.
10. Use the adjustments provided on the Test Post and the mount supporting the AS 2 to align the AS 2 so that the infinity reticle image of the MTC is in vertical and horizontal register with the reticle image of the AS 2.
11. If the infinity reticle image of the MTC is not sharp and distinct, then the MTC is not properly adjusted and must be corrected before proceeding to the next step. (See procedures for calibration of the Model #272-12 Multiple Target Collimator, page 31.)
12. Rotate the AS 2 180^{o} in its mount. Check for out of register condition of vertical wire images only. If out of register condition exists the reticle of the AS 2 must be adjusted.
13. Use the two horizontal reticle adjusting screws of the AS 2 to remove one half the apparent error. Remove the remaining error by using the tangent screws of the mount supporting the AS 2.

14. Rotate the AS 2 180° in its mount and verify the adjustment. Continue rotating 180° and adjusting until vertical wires remain in register.
15. Rotate the AS 2 90° and using only the adjusting screws of the AS 2 reticle adjust until the vertical wires are in register.
16. Bring both vertical and horizontal patterns into register and again rotate the AS 2 180°. If the adjustment is complete, the wires should remain in exact register both vertically and horizontally. If they do not, rotate the AS 2 90° and repeat steps 9 and 11 thru 14 until they remain in register.
17. If it is not possible to roll in the reticle, the position of the focusing lens relative to the optical-mechanical axis of the scope has been disturbed due to mishandling. The scope must be returned to the factory for adjustment.
18. Adjust the focusing knob of the AS 2 until the image of the four foot reticle of the MTC become sharp and distinct.
19. Adjust the AS 2 until the two reticle images are in vertical and horizontal register.
20. Rotate the AS 2 180° in its mount. Check for out of register condition of vertical wire only.
21. If out of register condition exists there may be error in the focusing lens and, or, the objective lens positioning. Adjustment of such an error is complex and should be referred to the factory for adjustment.

22. The auto-reflection target may now be checked. Always perform the reticle adjustment before attempting to adjust the auto-reflection target.

23. Place a Model #185 Stellite mirror on the adjustable mirror mount in front of the MTC.

24. Turn on light to AS 2.

25. Turn the focusing knob slowly until the auto-reflection target comes into sharp focus. This will occur when the AS 2 is focused to a distance equal to twice the distance of the auto-reflection target to the mirror.

26. Adjust either the mirror or the AS 2 until the reticle image is centered on the cross of the auto-reflection target pattern.

27. Rotate the AS 2 180^{o} in its mount and check for out of register condition of the vertical pattern only. If out of register condition is present remove one half the error using the horizontal auto-reflection target adjusting screws. Remove the remaining error using the tangent screws of the mount supporting the AS 2.

28. Rotate the AS 2 180^{o} in its mount and verify the adjustment. Continue rotating 180^{o} and adjusting until vertical patterns remain in register.

29. Rotate the AS 2 90^{o} and using only the adjusting screws of the AS 2 auto-reflection target adjust until the vertical pattern is in register.

30. Bring both vertical and horizontal patterns into register and again rotate the AS 2 180°. If the adjustment is complete, the patterns should remain in exact register both vertically and horizontally. If they do not, rotate the AS 2 90° and repeat steps 26 thru 29 until they remain in register.

31. The calibration of the Model #381-1 Alignment Scope is now complete.

H. Calibration of the Model #187-S Stride Level

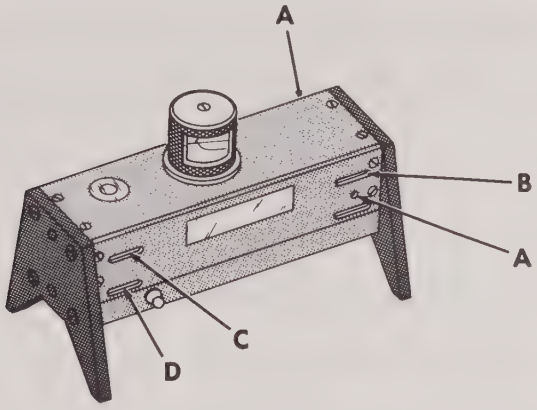


fig. 12

1. Remove the level from the MTC and then remove the MTC from the Target Post.
2. Place the MTC in the Model #88-6 Mounting Base or similar mount on a surface plate.
3. Place the level on the barrel and center the bullseye bubble. Use a pencil or piece of tape to mark its longitudinal position so that the level may be returned to the same position in subsequent steps.
4. Use the tilting adjustment provided on the mounting base to bring the split bubble into coincidence.
5. With the bubble in coincidence, roll the Stride Level away from you around the barrel until the bullseye bubble on top is tangent to the outside of the circle. See if the split bubble is still in coincidence. If not, roll adjustment must be made.

6. The roll adjustment is made by turning the opposed set screws bearing against the right hand vial adjusting screw. Access to the rear set screw is obtained by removing an allen head set screw in the main housing, directly opposite the vial adjusting screw. Access to the front screw is gained through hole (A) through the cover containing the window. (See fig. 12.) The upper adjusting nut on the right hand adjusting screw must be slightly loosened prior to making any adjustment. Access to this nut is through hole (B).

   (a) If the right side of the split bubble went up when the level was rolled away from you, loosen the front set screw and tighten the back set screw.

   (b) If the left side of the split bubble went up, loosen the rear set screw and tighten the front screw.

   NOTE: These are opposed set screws and both should be snug, not jammed, against the post at the completion of the adjusting process.

   (c) Re-snug the upper adjusting nut on the right hand adjusting screw.

   (d) Recheck roll to see that roll adjustment is now correct.

7. Check that the split bubble is still in coincidence when bullseye bubble is centered in vial. If it is not, adjust mount as necessary to bring bubble back into coincidence. Reverse the Stride Level on the collimator

barrel. Use the mark to assure that the Stride Level is in the same position as in step 2. Allow the split bubble to stabilize (5 to 10 seconds). Any error detected is double the error of the bubble axis with respect to gravity.

8. Use the tilt adjustment of the mounting base to take out half the observed error.

9. Remove the remaining error by adjusting the mount holding the level vial.

   (a) To adjust vial mount, loosen both top adjusting nuts through access holes (B) and (C) slightly, using the adjusting pin provided. (This pin is found in the box that contained the level.)

   (b) Use only the lower left hand adjusting nut to bring the bubble completely into coincidence. Access is through hole (D).

   (c) Resnug the upper adjusting nuts, making sure the bubble does not go out of coincidence.

10. Reverse the Stride Level. After bubble stabilization, if error is still observed, repeat steps 8 and 9. Continue this process until the bubble remains in coincidence.

11. Recheck the roll adjustment after completion of these steps.

I. Calibration of the Model #287-1 Leveling Mirror

The Model #287 Leveling Mirror series are all adjusted and calibrated using the same basic procedure. The Leveling Mirror can be adjusted * using any instrument that is equipped for auto-collimation. The only method which can be used for calibration * requires the use of an auto-collimator. This method also provides the most accurate means of adjustment. A word of caution. Whenever the Leveling Mirror is moved or adjustments are made, the mirror assembly must be in the "Up and Locked" position to prevent damage to the delicate knife edges. The only exception to this rule is when the tangent screw is being used to obtain small amounts of azimuth (rotational) correction.

1. Remove the Model #287-1 Leveling Mirror from the Target Post and place it on a surface plate or other vibration free mount.
2. Place the auto-collimating instrument in the Model #88-6 Mounting Base or similar mount so that it is aimed at the mirror and adjusted for vertical displacement.
3. Carefully lower the mirror into operating position.
4. (a) If an auto-collimator is used, adjust the auto-collimator to receive a reflected image of its reticle so that the reflected vertical wire image is in exact register with the vertical wire image of the reticle. Bracket the reflected offset horizontal image with the cursor and take a reading from the auto-collimator.

* Calibration implies the determination of the amount of error present, while adjustment implies only the correction of that error.

(b) If an instrument other than an auto-collimator is used, adjust the instrument to bring the reflected reticle image into exact vertical and horizontal register with the reticle image.

5. Raise the mirror out of the operating position and rotate the mirror assembly 180^{o}.
6. Carefully lower the mirror into operating position and re-acquire the reflected image as in step 4. Use the tangent screw of the level to acquire vertical wire register. Do not move the viewing instrument vertically.
7. Any difference between the position of the reflected image and the reticle image obtained in steps 4 and 6 represents twice the actual error between the true vertical and the mirror surface. If an auto-collimator is used take a reading and compute the error.
8. To remove the actual error note if the horizontal reflected wire image moved up or down with respect to its position in step 4. If it moved up the adjusting nuts along side the mirror must be moved away from the viewing instrument. If it moved down the adjusting nuts must be moved toward the viewing instrument.
9. Use the adjusting nuts and remove one half the error.
10. Repeat steps 4 thru 9 and verify the adjustment.

VIII MAINTENANCE

The Universal Short Range Calibrator, under normal conditions, should require very limited periodic maintenance. Maintenance which might be required is primarily preventive in nature.

A periodic wiping of the barrels of the Model #81, Model #381-1, and #272-12 with a lightly oiled rag followed by wiping with a dry cloth will assure that no corrosion or rusting of the barrel O. D. occurs.

A brownish discoloration may be noticed on the intermediate tube of the Test Post. This is not rust. It is a brass powder that is picked up by the Test Post as the post is raised and/or lowered to accommodate various instruments. A periodic wiping of this tube with a lightly oiled cloth is recommended also.

Other mechanical components such as the precision slide, the Level Base Assembly, Lift Stand Assembly, etc., have been lubricated at the factory and normally will not require lubrication in the field. If because of adverse conditions maintenance or repair of mechanical equipment is required, the equipment should be disassembled, cleaned carefully in Naptha (MIL-N-15178 or equal), greased lightly with MIL-G-21164 and reassembled. Be sure any excess of grease is removed.

Removal of the Optical Plummet Unit from the Calibrator

1. Open the Cabinet doors.
2. Unscrew the lighting attachment from the Eyepiece Adapter.
3. Use a .050" Allen wrench to loosen the #4-40 NC-2 set screws in each Axis Adjusting Screw. (See fig. 29, page 74.)
4. Loosen the Lock Ring at the top of the Plummet Adapter Tube and unscrew the Adaptor Tube completely from the bottom of the Test Post. Note the orientation of the unit before removal so that it may be reinstalled in the same position.
5. Place the adaptor tube threaded end down on a bench.
6. Remove the three #4-40 NC-2 round head screws that secure each control cable bracket. Remove the brackets.
7. Back out the Axis Adjusting Screws to remove some of the spring tension from the spring loaded plunger opposite each adjusting screw. (Do not remove adjusting screws.)
8. Remove the Spring Body, Spring and Plunger opposite each adjusting screw.
9. Remove the Axis Adjusting Screws.
10. Remove the four #10-32 NF-2 socket head cap screws that secure the Spherical Mount Ring in the adapter tube.
11. Carefully lift the Optical Plummet Collimator from the adapter tube.
12. Unscrew the Eyepiece Adapter from the collimator barrel.

13. Note the position and orientation of the Axis Ring (so that it may be returned to this position) and loosen the four #3-56 NF-2 socket set screws that secure the Axis Ring to the collimator barrel. Remove the Axis Ring.

14. Screw the Eyepiece Adapter back on the collimator barrel.

15. The collimator is now ready for calibration.

NOTE: Do not remove the Spherical Mount Ring from the front of the collimator barrel.

16. To reassemble reverse the preceeding steps.

PARTS LISTS

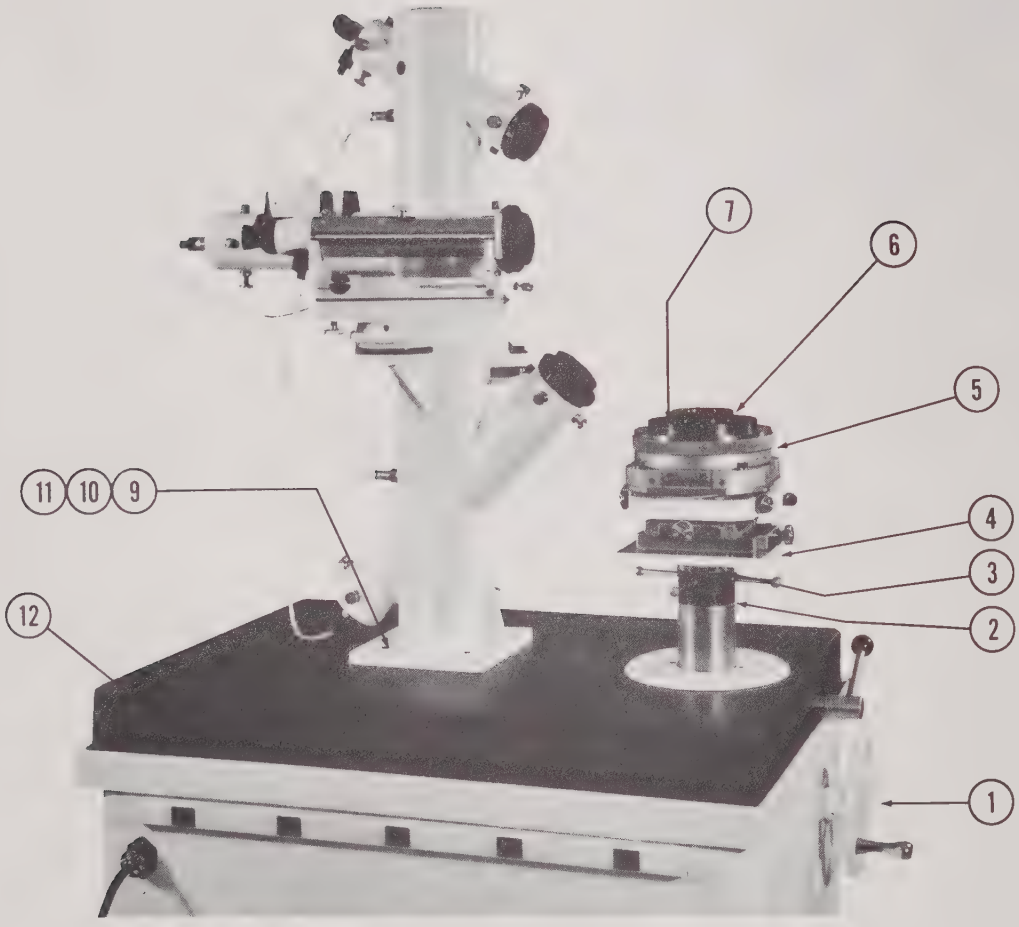


fig. 13

TEST POST AND BASE

	Name	Part No.	Qty.
1.	Ass'y. - Handwheel	11124-G1	1
2.	Precision Lift	4397-G2	1
3.	Lock Ring	11134	1
4.	Ass'y. - Bottom Plate	11135-G1	1
5.	Ultradex 7" MARK II Model A	Comm.	1
6.	Inst. Mount 3-1/2 - 8 Thr'd.	11139	1
7.	Scr. #1/4 - 20 NC - 2 X 1/2 S. H. C.	Comm.	4
8.	Scr. #1/4 - 20 NC - 2 X 3/4 S. H. C.	Comm.	4
9.	Scr. #3/8 - 16 NC - 2 X 4 S. H. C.	Comm.	4
10.	Lock Washer 3/8" *	Comm.	4
11.	Hex Nut #3/8 - 16 NC - 2 *	Comm.	4
12.	Ass'y. Base (Includes four Handles Part No. 11008)	11009-G1	1

* Located on underside of base

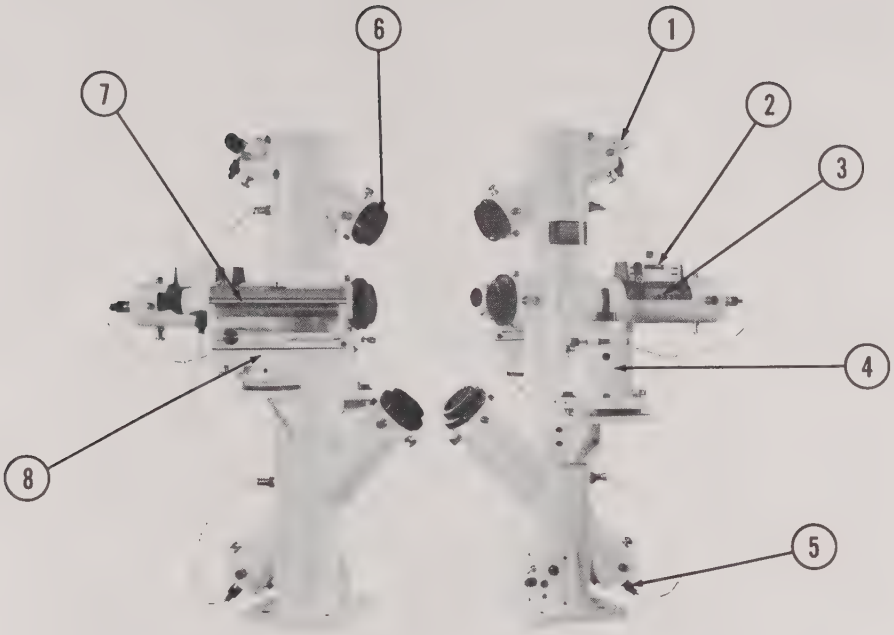


fig. 14

TARGET POST INSTRUMENTS

	Name	Part No.	Qty.
1.	Alignment Scope (Model 381-1)	3200-G1	1
	Includes: Barrel Extension	11176	
	Collimation Light	7868-G5	
2.	Stride Level (Model 187-S)	5740-G1	1
3.	Multiple Target Collimator (Model 272-12)	4475-G1	1
	(includes Collimation Light	7868-G4	
4.	Leveling Mirror (Model 287-1)	9390-G1	1
5.	Infinity Target Collimator (Model 272-1)	8865-G1	1
	(includes Collimation Light	7868-G4	
6.	Stellite Mirror (Model 185)	5202-G1	3
7.	Alignment Scope (Model 81)	2600-G2	1
	(includes Collimation Light	7868-G5	
8.	Mounting Base (Model 88-6)	2979-G5	1

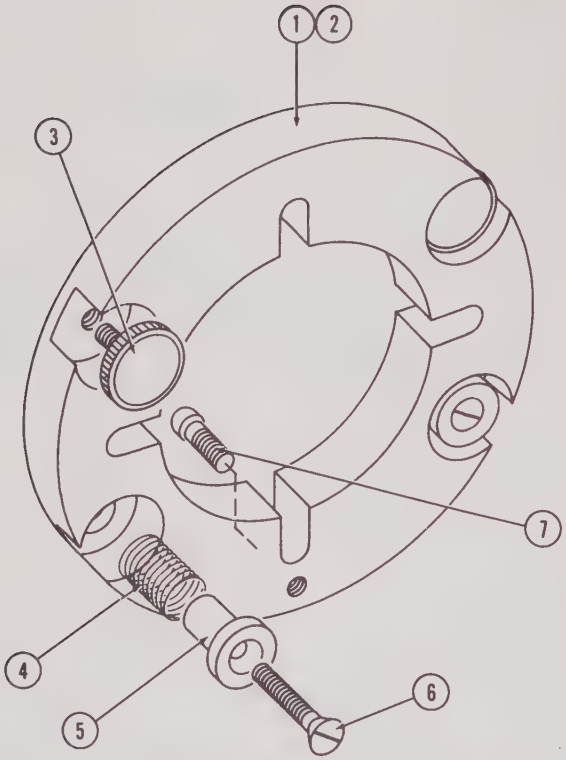
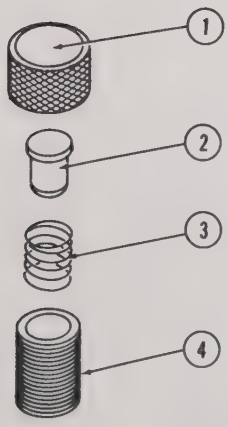


fig. 15

MIRROR MOUNT (3 REQ'D)

	Name	Part No.	Qty.
1.	Adaptor 30° Tube	11171	1
2.	Adaptor 45° and 90° Tube	11170	1
3.	Adjusting Screw	11172	2
4.	Spring	11173	2
5.	Spring Retainer	11174	2
6.	Scr. #5-40 NC - 2 X 1 F. H.	Comm.	2
7.	Pivot	11175	1

SPRING LOADED SCREW (12 REQ'D)



	Name	Part No.	Qty.
1.	Cap	11165	1
2.	Plunger	11168	1
3.	Spring	11167	1
4.	Body	11166	1

fig. 16

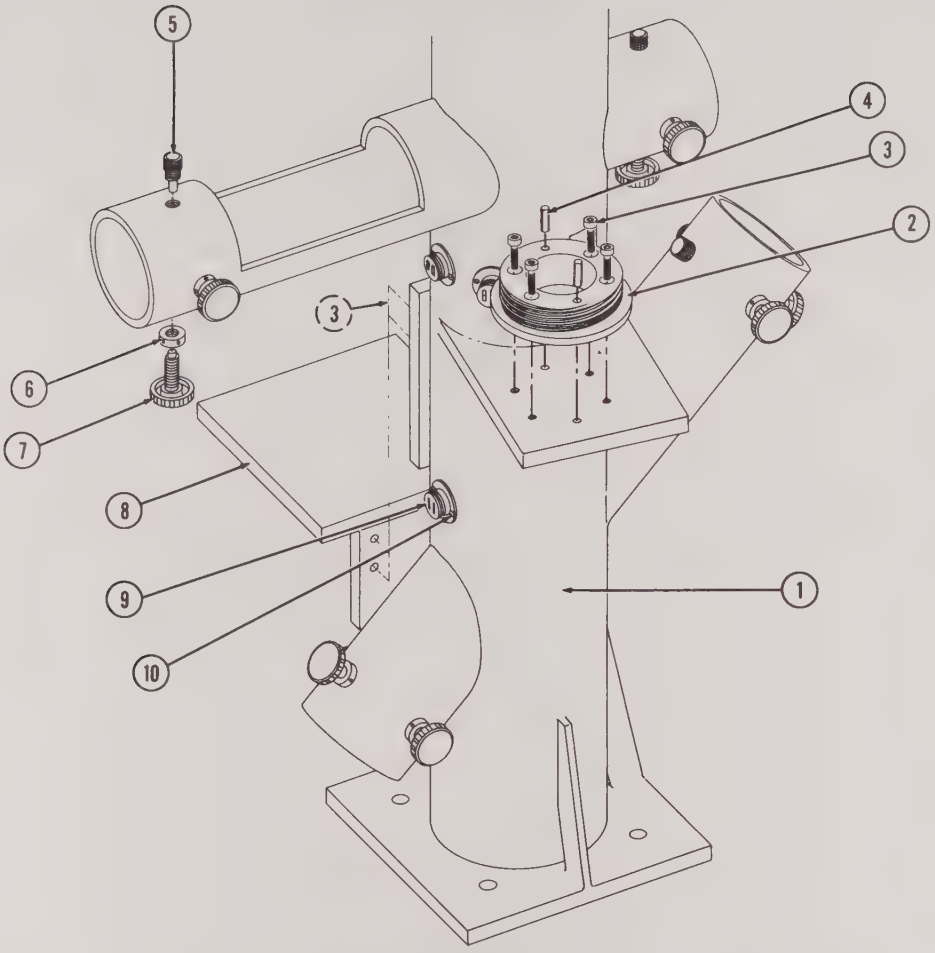
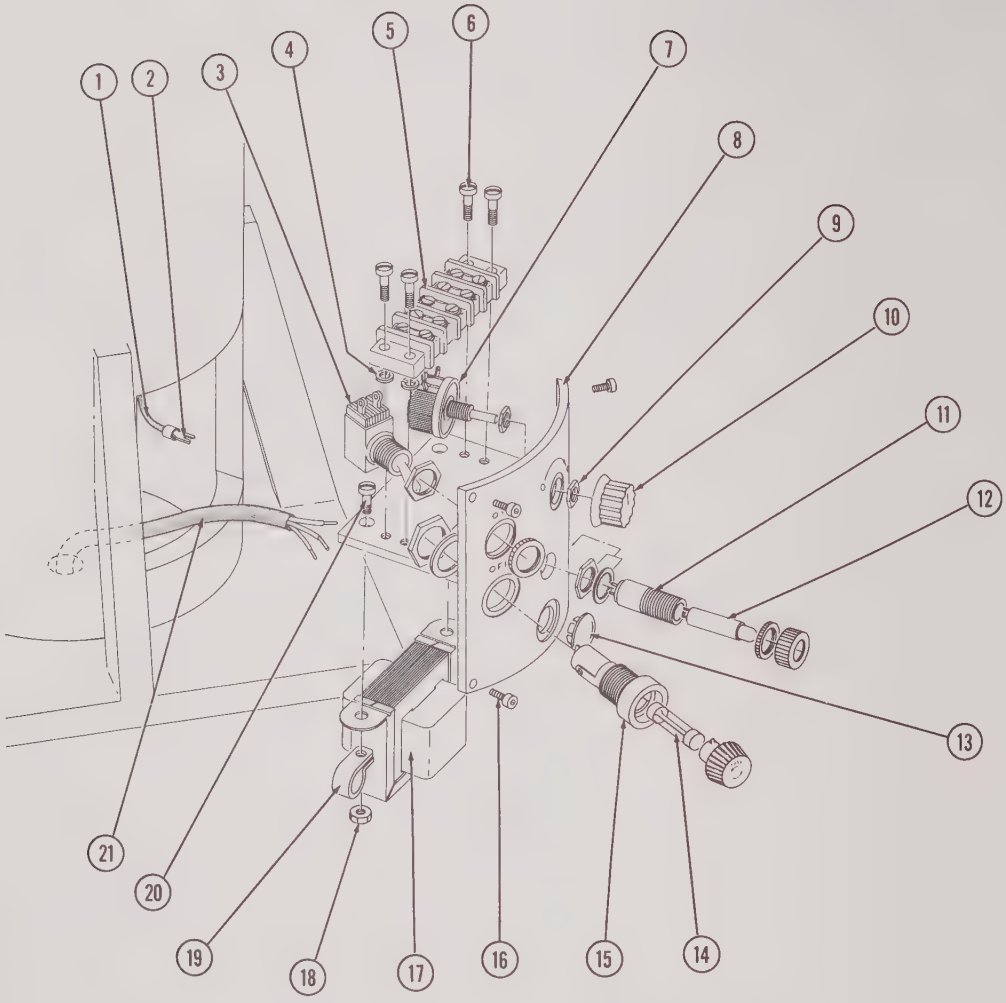


fig. 17

TARGET POST

	Name	Part No.	Qty.
1.	Target Post	11151-G1	1
2.	Mounting Ring Model 197 (3-1/2 - 8 thread)	2437	1
3.	Scr. #1/4 - 20 NC - 2 X 1 S. H. C.	Comm.	8
4.	Steel Dowel .250 Dia. X 1	Comm.	2
5.	Ass'y. - Spring Loaded Screw	11164-G1	12
6.	Adjusting Nut	3561	12
7.	Screw - Leveling	11143	12
8.	Bracket - Inst. Support	11155	1
9.	Electrical Socket (Cinch Jones #5202 B)	Comm.	4
10.	Scr. #5 - 40 NC - 2 X 3/8 F. H.	Comm.	8



ELECTRICAL CONTROL PANEL ASSEMBLY

	Name	Part No.	Qty.
1.	Wire (to inst. light sockets)	Comm.	As Req'd.
2.	Spade Lug	Comm.	8
3.	Toggle Switch SPST 3 Amp. at 250 Volts (Arrow - Hart & Hegeman #20994NV)	Comm.	1
4.	Lockwasher #5	Comm.	4
5.	Barrier Strip	Comm.	1
6.	Scr. #5-40 NC - 2 X 1/2 Binder Hd.	Comm.	4
7.	Rheostat 25 Ohm - . 71 Amp. (Ohmite #0108)	Comm.	1
8.	Mount - Control Unit	11157	1
9.	Hex Nut #3/8 - 32 NF - 2	Comm.	1
10.	Rheostat Knob	Comm.	1

11.	Pilot Light Housing (Dialco #7538)	Comm.	1
12.	Neon Pilot Light (Dialco #507-5338-0931-610)	Comm.	1
13.	Plug	Comm.	1
14.	Fuse 1/4 Amp.	Comm.	1
15.	Fuse Holder	Comm.	1
16.	Scr. #5-40 NC-2 X 3/8 S. H. C.	Comm.	4
17.	**Transformer - Filament Type** **Primary: 117 Volts, 60 Cycles** **Secondary: 6. 3 Volts, C. T. at 1. 2 Amp.** **(Stancor #P-6134)**	Comm.	1
18.	Hex Nut #10-32 NF-2	Comm.	2
19.	Wire Harness	Comm.	1
20.	Scr. #10-32 NF-2 X 3/4 Binder Hd.	Comm.	4
21.	Ref. 110 Volt Power Supply		

WIRING SCHEMATIC

ELECTRICAL CONTROL PANEL

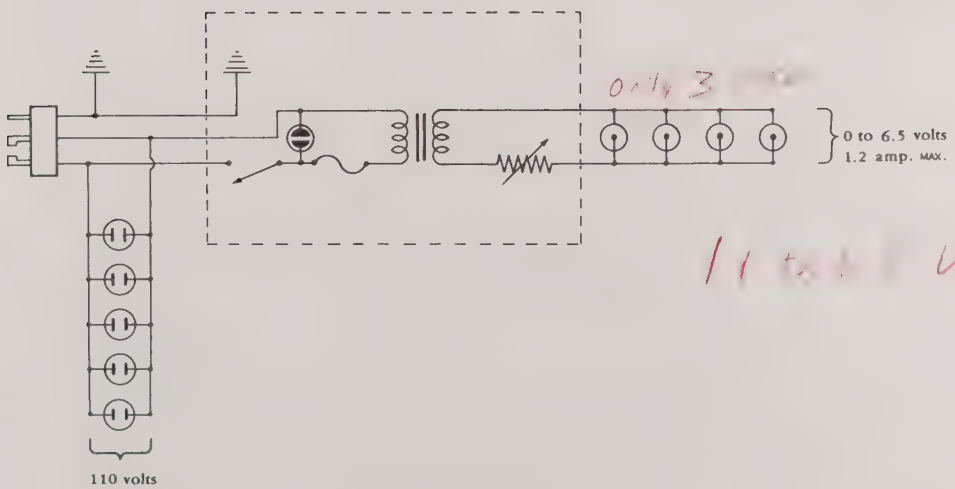


fig. 19

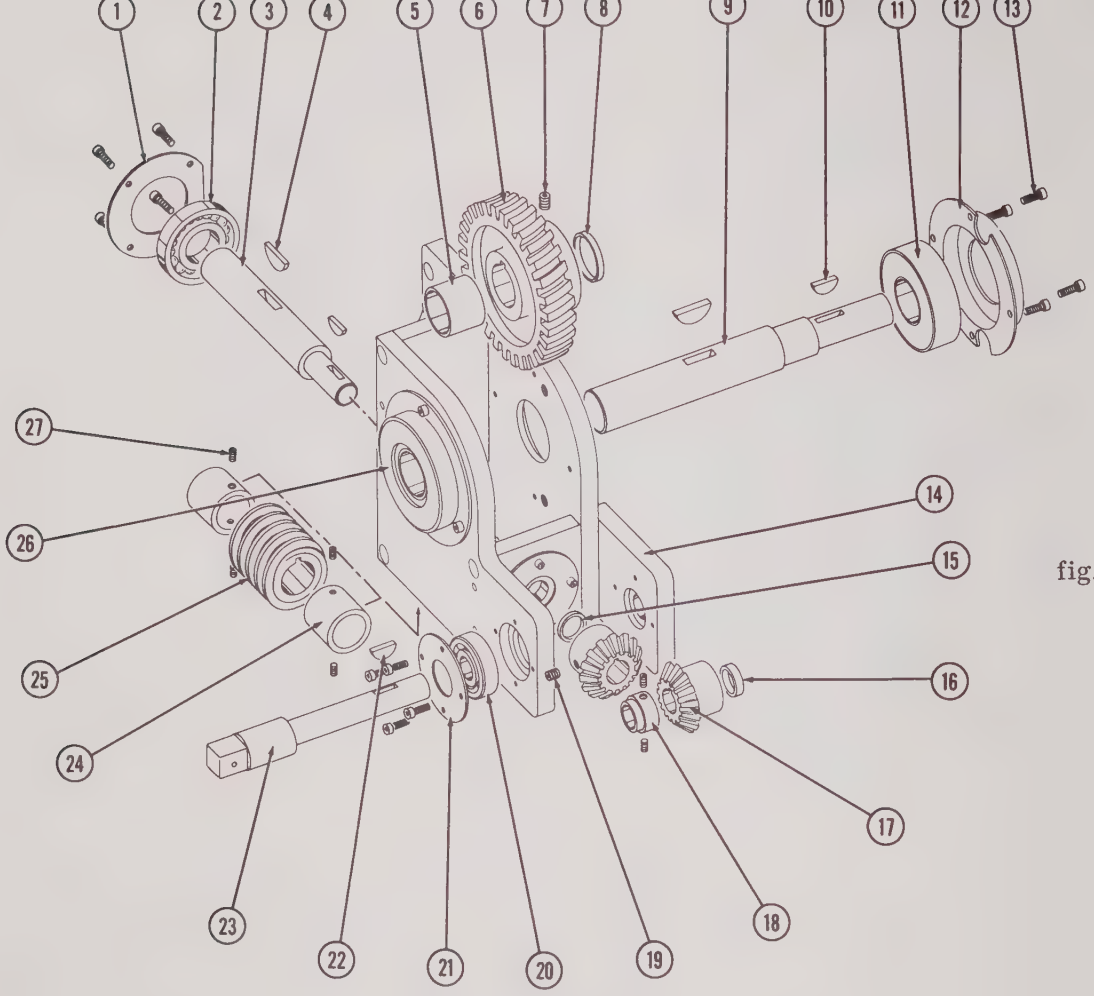


fig. 20

GEAR BOX ASSEMBLY

	Name	Part No.	Qty.
1.	Keeper Ring 3/4"	11112	1
2.	Bearing Fafnir S8K	Comm.	1
3.	Intermediate Shaft	11020	1
4.	Key #9 Woodruff	Comm.	2
5.	Thrust Collar 7/8"	11078	1
6.	Driven Gear	11116	1
7.	Scr. #1/4 - 20 NC - 2 X 1/4 S. H. S.	Comm.	1
8.	Thrust Washer 7/8"	11018	1
9.	Upper Shaft	11120	1
10.	Key #6 Woodruff	Comm.	1
11.	Bearing Nice 1640 DS	Comm.	2
12.	Bearing Holder Cup	11118	1
13.	Scr. #4 - 40 NC - 2 X 3/8 S. H. C.	Comm.	24
14.	Gear Box	11125	1
15.	Thrust Washer	11144-1	1
16.	Thrust Washer	11144	1
17.	Miter Gear Boston HLK 101Y	Comm.	2
18.	Thrust Collar 1/2"	11117	1

19.	Scr. #1/4 - 20 NC - 2 X 1/4 S. H. S.	Comm.	2
20.	Bearing Fafnir S5K	Comm.	3
21.	Keeper Ring 1/2"	11113	3
22.	Key #3 Woodruff	Comm.	2
23.	Ass'y. Input Shaft	11115-G1	1
24.	Thrust Spacer	11126	2
25.	Worm Boston H-1418	Comm.	1
26.	Bearing Holder Cup	11118-1	1
27.	Scr. #5 - 40 NC - 2 X 1/4 S. H. S.	Comm.	6

MISCELLANEOUS

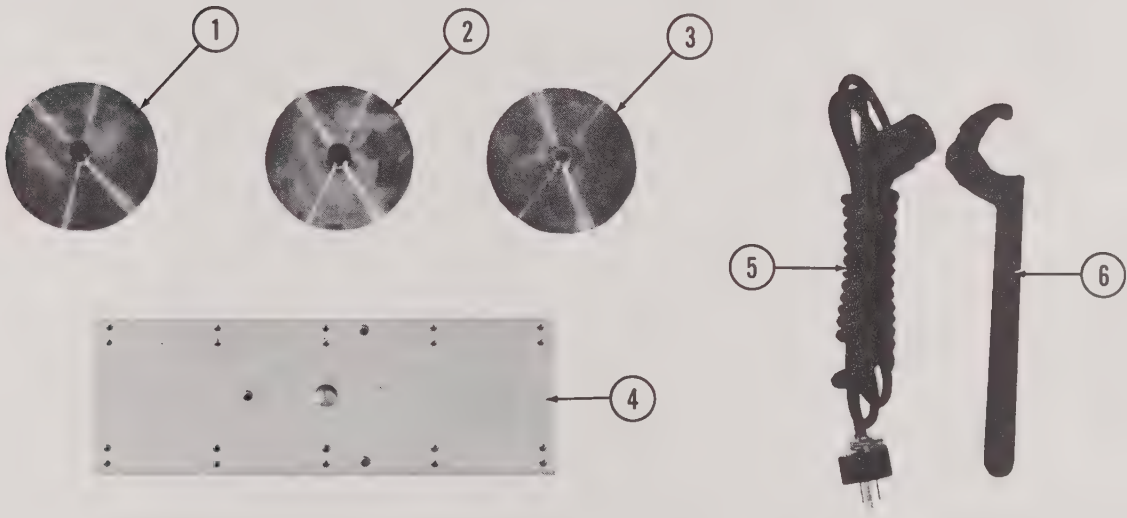


fig. 21

	Name	Part No.	Qty.
1.	Theodolite Adapter Model #235-5	6384	1
2.	Theodolite Adapter Model #235-7	4619	1
3.	Theodolite Adapter Model #235-14	11025	1
4.	Alidade Plate	11007	1
5.	Power Cord	11058-G1	1
6.	Spanner Wrench	11024	1
7.	Tool Kit (not shown)	11178-G1	1

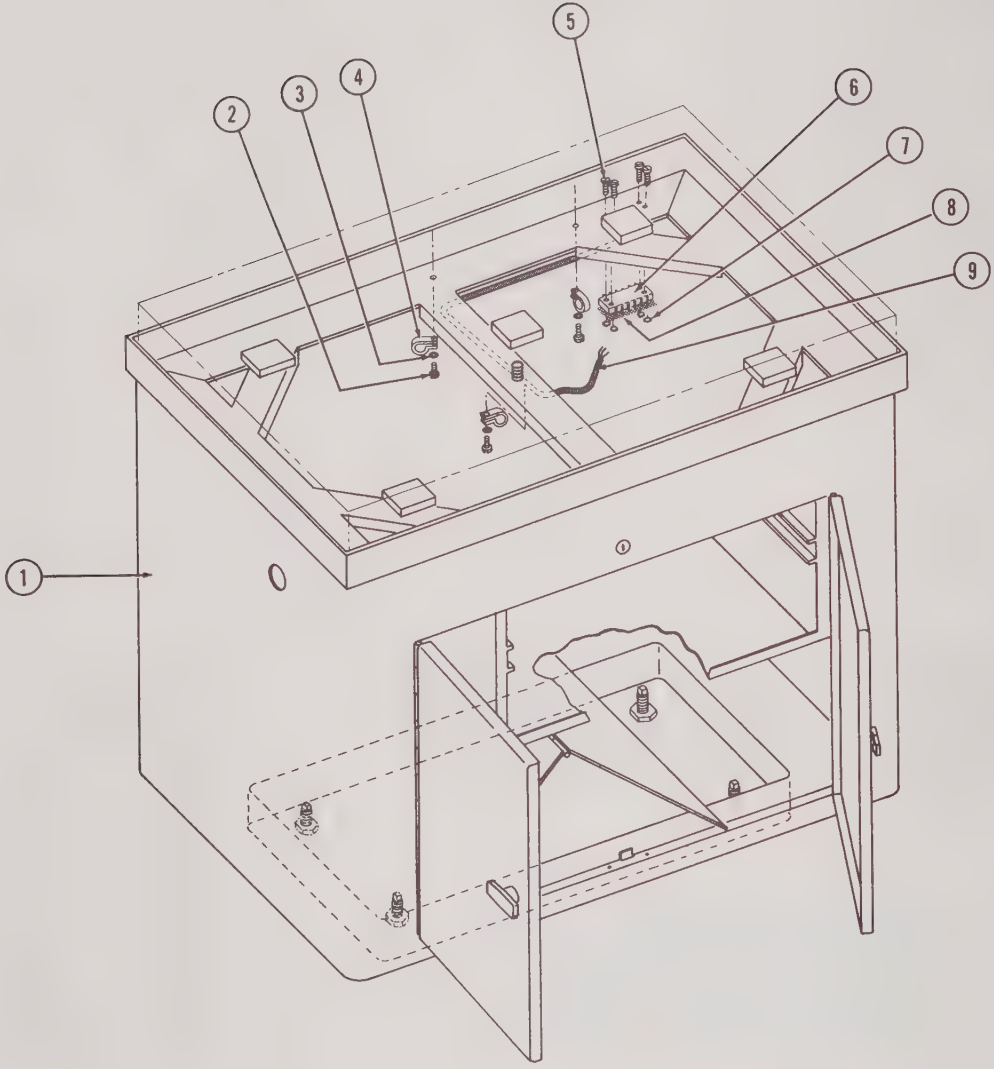


fig. 22

CABINET WIRING (INTERNAL)

	Name	Part No.	Qty.
1.	Cabinet	11130	1
2.	Scr. #6-32 NF - 2 X 3/8 Binder Hd.	Comm.	3
3.	Lockwasher #6	Comm.	3
4.	Wire Harness	Comm.	3
5.	Scr. #5 - 40 NC - 2 X 1 Binder Hd.	Comm.	4
6.	Barrier Strip	Comm.	1
7.	Hex Nut #5-40 NC - 2	Comm.	4
8.	Insulation	Comm.	As Req'd.
9.	Wire Beldon 18-3 SJ or Equal	Comm.	3 ft.

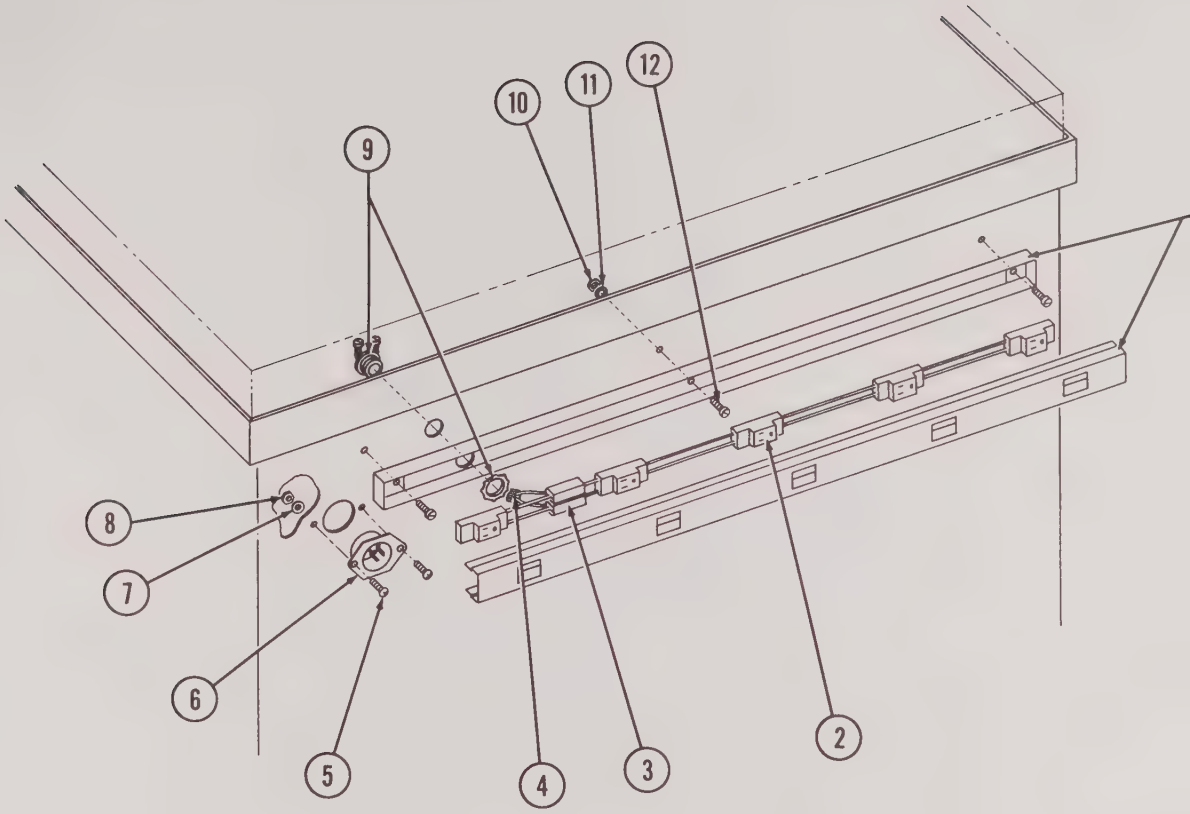


fig. 23

CABINET WIRING (EXTERNAL)

	Name	Part No.	Qty.
1.	Outlet Moulding	Comm.	1
2.	Outlet Strip (grounded)	Comm.	1
3.	Solderless Connector	Comm.	2
4.	Wire Beldon 18 - 3 SJ or Equal	Comm.	1 ft.
5.	Scr. #6 - 32 NC - 2 X 1/2 Phillips Rd. Hd.	Comm.	2
6.	Socket Hubble 4716 Twist Lock	Comm.	1
7.	Lock Washer #6	Comm.	2
8.	Hex Nut #6-32 NC - 2	Comm.	2
9.	Wire Feedthrough	Comm.	1
10.	Hex Nut #10-32 NF - 2	Comm.	3
11.	Lock Washer #10	Comm.	3
12.	Scr. #10-32 NF - 2 X 1/2 Binder Hd.	Comm.	3

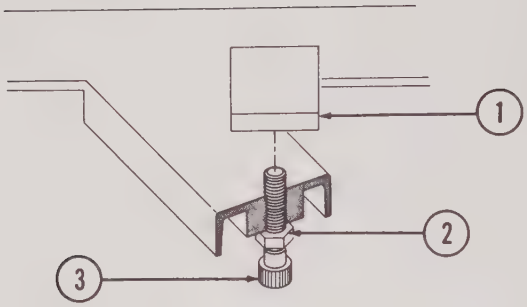


fig. 24

BASE PLATE LEVEL

	Name	Part No.	Qty.
1.	Level Pad	11005	6*
2.	Jam Nut #1/2 - 20 NC - 2	Comm.	6*
3.	Scr. #1/2 - 20 NC - 2 X 1-3/4 S. H. C.	Comm.	6*

* There are only five units on USRC 01 thru 10

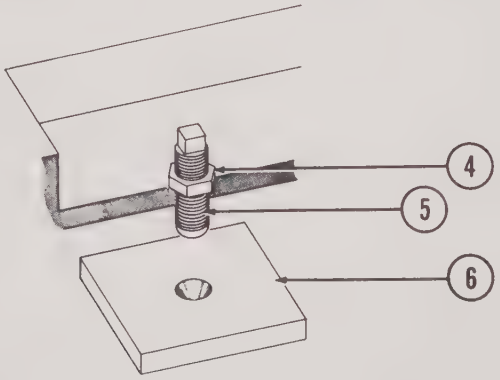


fig. 25

CABINET LEVEL

4.	Jam Nut #3/4 - 16 NF - 2	Comm.	4
5.	Level Screw	11017	4
6.	Level Foot	11006	4

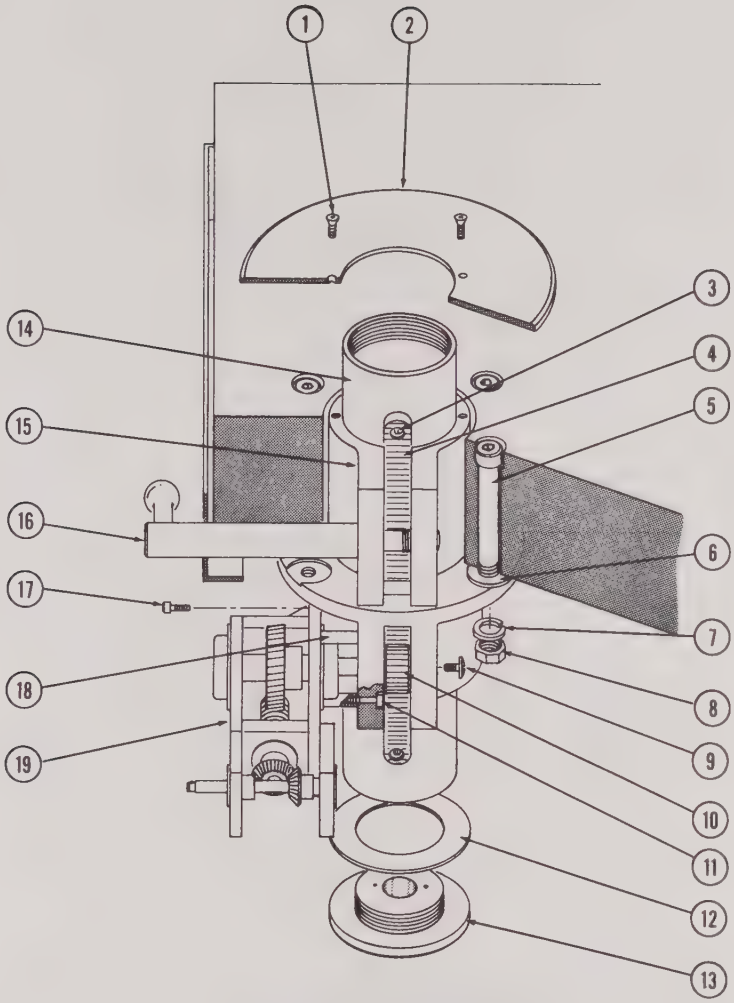


fig. 26

LIFT STAND ASSEMBLY

	Name	Part No.	Qty.
1.	Scr. #8 - 32 NC - 2 X 1 F.S.H.	Comm.	2
2.	Cover-Lift Stand	11145	1
3.	Scr. #10 - 32 NF - 2 X 1/2 S.H.C.	Comm.	4
4.	Rack	3666	1
5.	Scr. #1/2 - 20 NF - 2 X 4-1/2 S.H.C.	Comm.	5
6.	Spacer	11016	5
7.	Lock Washer 1/2"	Comm.	3
8.	Hex Nut #1/2 - 20 NF - 2	Comm.	3
9.	Screw - Keeper	3611	1
10.	Pinion	3610	1
11.	Scr. #1/4 - 20 NC - 2 X 1-1/2 S.H.C.	Comm.	2
12.	Rubber Stop Washer*	11129	1
13.	Stop Plug*	11133	1
14.	Intermediate Tube	11128	1
15.	Collar	11132	1
16.	Ass'y. - Clamp Arm	11131-G1	1
17.	Scr. #1/4 - 20 NC - 2 X 3/4 S.H.C.	Comm.	4
18.	Spacer Tube	11019	2
19.	Ass'y. - Gear Box	11111-G1	1

* Not used when unit is equipped with an Optical Plummet Collimator

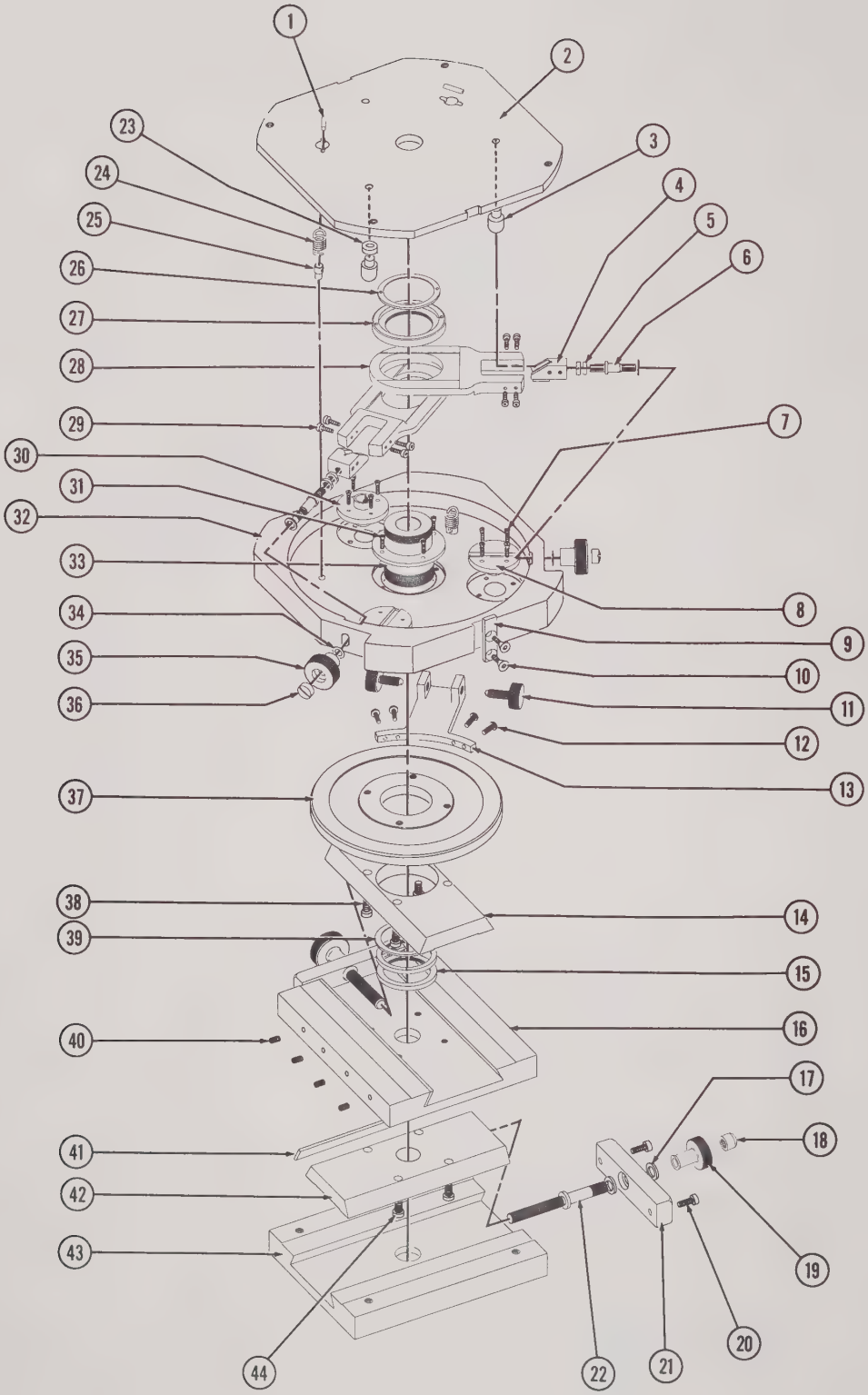


fig. 27

ADJUSTING DEVICES ASSEMBLY

	Name	Part No.	Qty.
1.	Steel Dowel . 125 Dia. X 3/4	Comm.	2
2.	Top Plate	11062	1
3.	Ball	11102	3
4.	Wedge	11084	2
5.	Lock Nut	11147	4
6.	Leveling Screw	11103	2
7.	Scr. #4 - 40 NC - 2 X 1/2 F. S. H.	Comm.	12
8.	Wear Plate	11087	2
9.	Arrestor Plate	11146	2
10.	Scr. #8 - 32 NC - 2 X 1/2 F. S. H.	Comm.	4
11.	Tangent Knob	11107	2
12.	Scr. #5 - 40 NC - 2 X 1/2 Button Hd.	Comm.	4
13.	Tangent Arm	11106	1
14.	Dovetail (upper)	11074-1	1
15.	Socket Retainer	11098	2
16.	Slide	11072-1	1
17.	Washer	11065	4
18.	Lock Nut	11066	2
19.	Knob	11080	2
20.	Scr. #8 - 32 NC - 2 X 3/4 S. H. C.	Comm.	4
21.	End Block	11077	2
22.	Shaft	11079	2
23.	Spacer	11148	3
24.	Tension Spring	11088	2
25.	Spring Lug	11083	2
26.	Lock Ring	11086	1
27.	Keeper Ring	11085	1
28.	Slide	11063	2
29.	Scr. #5 - 40 NC - 2 X 9/16 S. H. C.	Comm.	8
30.	Pivot Wear Plate	11082	1
31.	Scr. #5 - 40 NC - 2 X 3/8 F. S. H.	Comm.	4
32.	Base	11061	1
33.	Center Guide	11064	1
34.	Washer	11105	4
35.	Level Knob	11104	2
36.	Nut - Leveling Knob	11081	2
37.	Rotation Plate	11091	1
38.	Scr. #8 - 32 NC - 2 X 3/8 S. H. C.	Comm.	4
39.	Spacer	11099	1
40.	Scr. #5 - 40 NC - 2 X 1/4 S. H. S.	Comm.	8
41.	Gib	11075	2
42.	Dovetail (lower)	11074	1
43.	Slide	11072	1
44.	Scr. #8 - 32 NC - 2 X 5/8 S. H. C.	Comm.	4

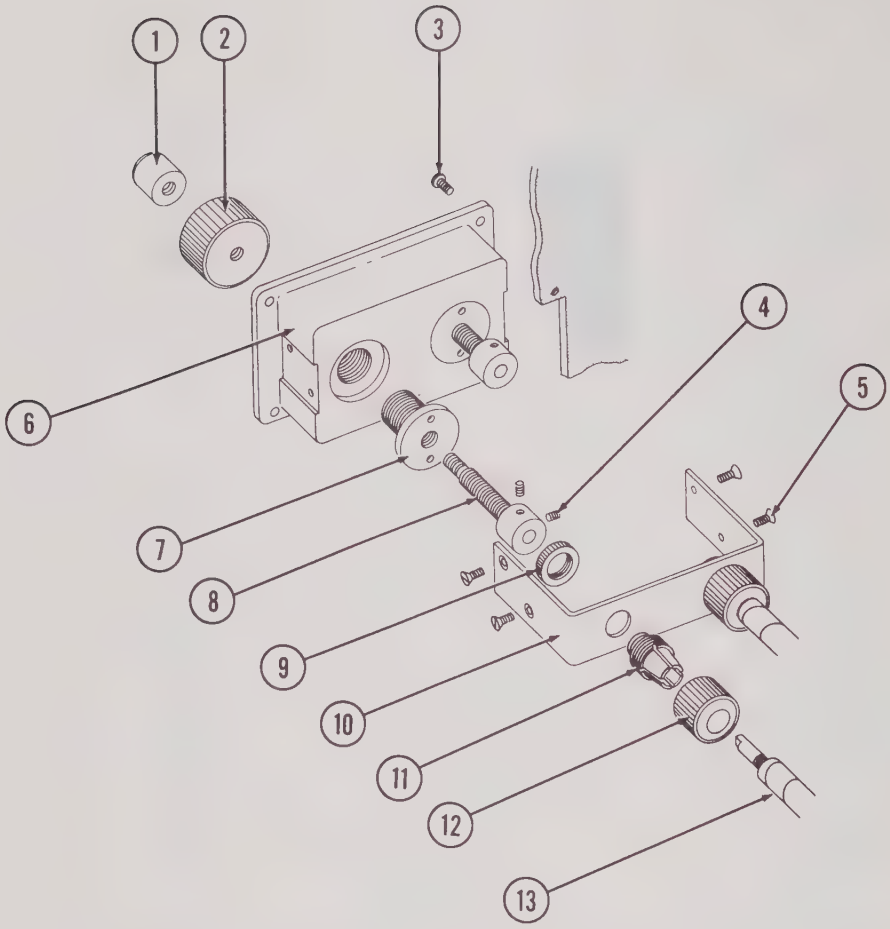


fig. 28

AXIS CONTROL PANEL ASSEMBLY

	Name	Part No.	Qty.
1.	Lock Nut - Knob	11192	2
2.	Control Knob	11193	2
3.	Scr. #5-40 NC-2x1/2 Oval Hd.	Comm.	4
4.	Scr. #4-40 NC-2x1/8 Soc. Hd. Set	Comm.	4
5.	Scr. #3-56 NF-2x1/4 Soc. Flat Hd.	Comm.	4
6.	Axis Control Panel	11188	1
7.	Bushing - Control Scr.	11190	2
8.	Axis Control Scr.	11191	2
9.	Retainer Nut - Collet	11186	2
10.	Collet Bracket	11189	1
11.	Collet	11183	2
12.	Collet Nut	11184	2
13.	Ass'y. - Cable (For Reference Only)		

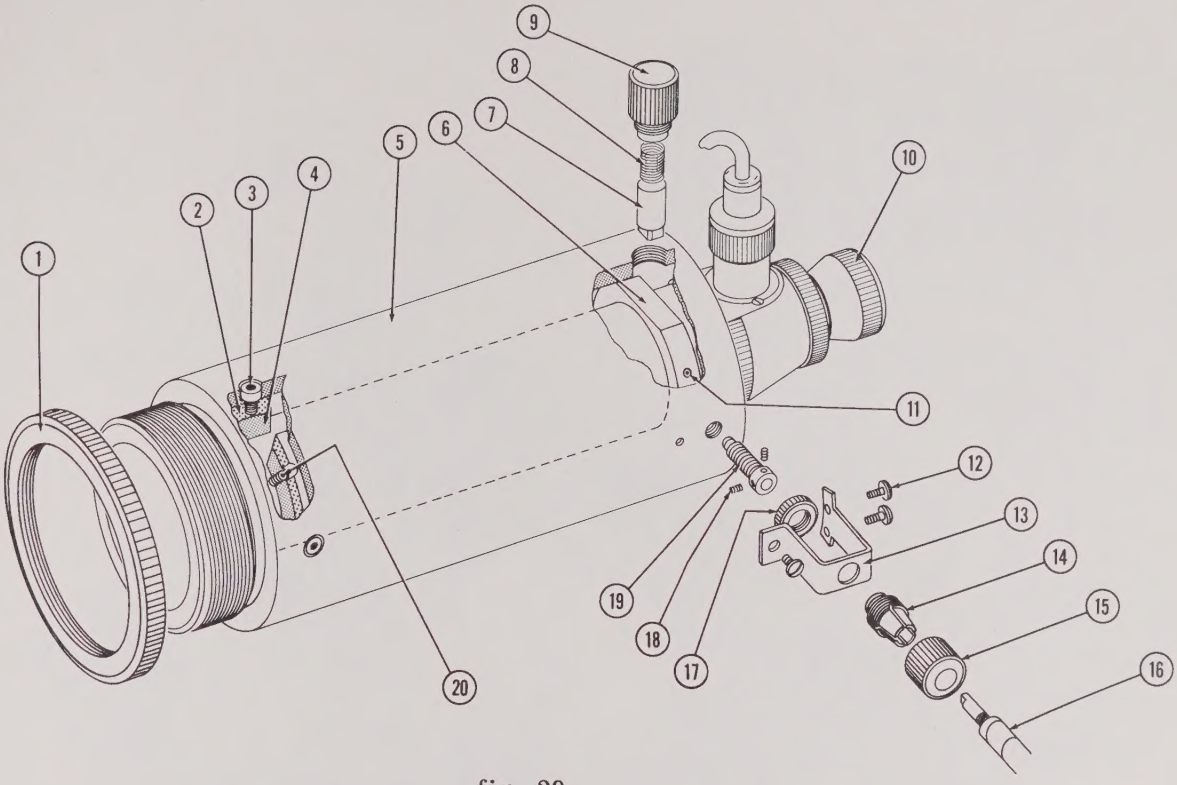


fig. 29

OPTICAL PLUMMET UNIT ASSEMBLY

	Name	Part No.	Qty.
1.	Lock Ring	11033	1
2.	Spherical Mount Ring	11034	1
3.	Scr. #10-32 NF-2x5/16 Soc. Hd. Cap	Comm.	4
4.	Spherical Mount Ass'y.	6768-G1	1
5.	Plummet Adaptor Tube	11032	1
6.	Axis Ring	11036	1
7.	Plunger	11038	2
8.	Spring	11039	2
9.	Spring Body	11037	2
10.	Optical Plummet Collimator	11196-G1	1
11.	Scr. #3-56 NF-2x1/8 Soc. Hd. Set	Comm.	4
12.	Scr. #4-40 NC-2x1/4 Rd. Hd.	Comm.	6
13.	Bracket	11182	2
14	Collet	11183	2
15.	Collet Nut	11184	2
16.	Ass'y. - Cable	11029-G1	2
17.	Retainer Nut - Collet	11186	2
18.	Scr. #4-40 NC-2x1/8 Soc. Hd. Set	Comm.	4
19.	Axis Adj. Scr.	11187	2
20.	Scr. #4-40 NC-2x3/16 Soc. Hd. Set	Comm.	2

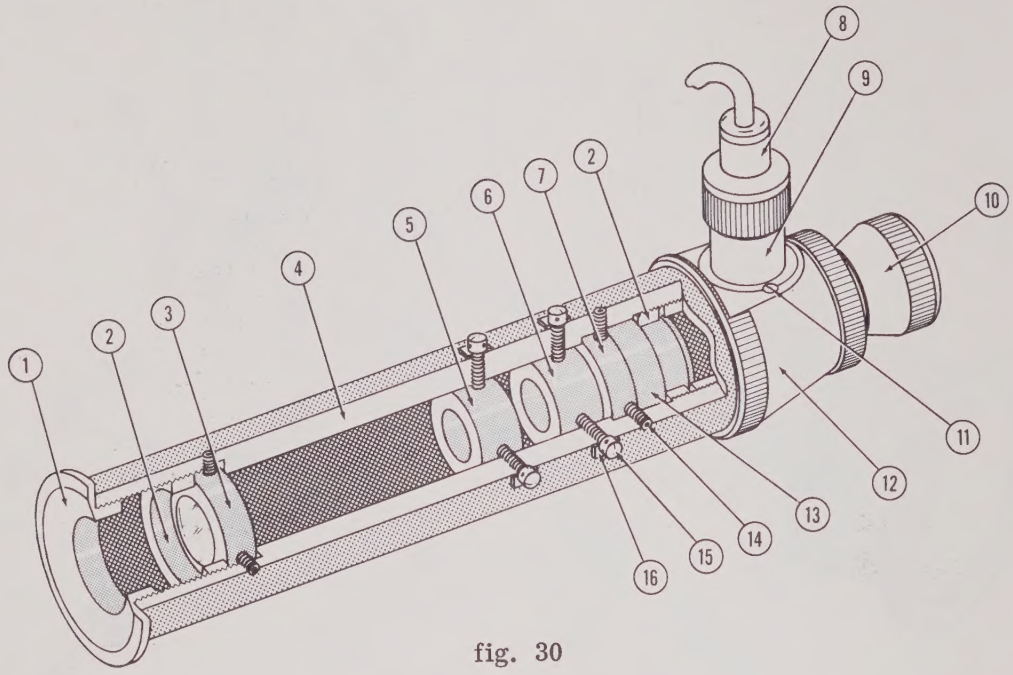


fig. 30

OPTICAL PLUMMET COLLIMATOR ASSEMBLY

	Name	Part No.	Qty.
1.	Cap - Objective	11194	1
2.	Retainer	2902	2
3.	Ass'y. - Objective Lens	2908-G1	1
4.	Barrel	11197	1
5.	Ass'y. - Reticle (4 ft.)	11213-G1	1
6.	Ass'y. - Reticle (15 ft.)	11213-G2	1
7.	Ass'y. - Cross Wire	6538-G1	1
8.	Ass'y. - Light Housing	2630-G1	1
9.	Mount - Reflector	2631-G3	1
10.	Ass'y. - Eyepiece	2933-G1	1
11.	Scr. #1-72 NF-2x1/8 Flat Hd.	Comm.	2
12.	Adaptor - Straight	2932	1
13.	Ass'y. - Erector Lens	2928-G1	1
14.	Scr. - Adjustment	2613	12
15.	Scr. - Reticle Adjustment	5021	8
16.	Collet - Reticle	5043	8

BRUNSON

BRUNSON INSTRUMENT COMPANY

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